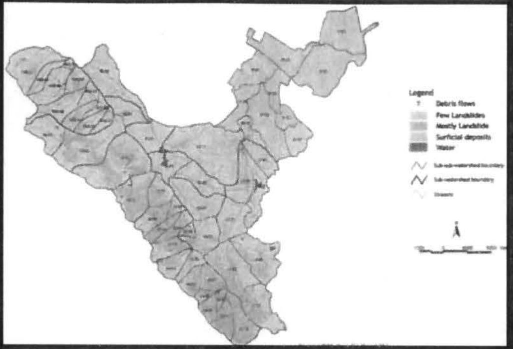

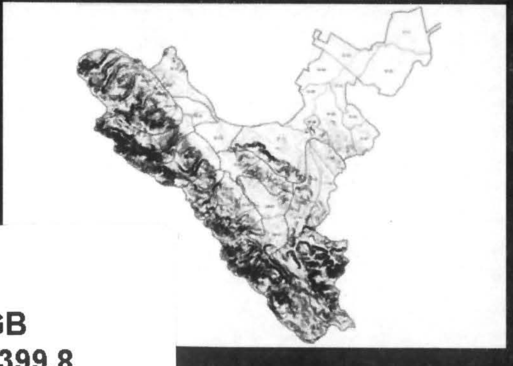

San Francisquito Creek Watershed Existing Conditions Analysis

FINAL REPORT

Prepared for:

San Francisquito Creek
Joint Powers Authority

Prepared by:

nhc northwest hydraulic consultants
Leaders in water resource technology

Jones & Stokes

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San Francisquito Creek
Watershed Analysis and Sediment Reduction Plan

Task 4.2
Existing Conditions Analysis

Final Report
January 9, 2004

Prepared for:
San Francisquito Creek
Joint Powers Authority

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1. INTRODUCTION

1.1 Objectives

The objective of Task 4.2 is to describe the existing conditions of the San Francisquito Watershed including general characteristics, land uses, biological resources, stream management and maintenance and riparian corridor management policies and programs, and designated watershed beneficial uses.

1.2 Approach

The approach that was taken for this report included reviewing existing reports, maps, and other information for the San Francisquito watershed that are relevant to our objective of describing the existing conditions of the watershed.

The existing conditions analysis is an important precursor to the Task 5 Watershed Sediment Analysis and also to the Task 7 Sediment Reduction Plan. Because these two following tasks rely on different information, we have divided the existing conditions analysis into the following parts:

- A general description of the San Francisquito watershed;
- An overview of the watershed characteristics;
- A discussion of historic and existing lands uses, and trends over time;
- A review of historic and existing biological resources and habitats within the watershed;
- A description of stream management and maintenance programs and activities
- A summary of existing riparian corridor management policies and programs; and,
- Beneficial uses that have been designated within the watershed.

1.3 Sources of Information

A broad range of studies and information is available, describing the physical and biological characteristics of the San Francisquito Watershed. For the purposes of this study, the following sources of information were reviewed:

- Historic and current topo maps and air photos;
- Santa Clara Basin Watershed Management Initiative;
- California Department of Fish and Game Natural Diversity Database;
- U.S. Fish and Wildlife Service and U.C. Santa Barbara Gap Analysis Habitat Mapping; and,
- General studies that have been provided by the Technical Advisory Committee and the Santa Clara Basin Watershed Management Initiative public data repository, housed at the Palo Alto Regional Water Quality Control Plant.

2. SAN FRANCISQUITO WATERSHED

2.1 Physiography and Geology

The San Francisquito watershed is approximately 45 mi^2 in size. Most of the watershed lies in the Santa Cruz Mountains and Bay Foothills southwest of Palo Alto; the remaining 7.5 mi^2 of the watershed lies on the San Francisquito alluvial fan near San Francisco Bay. The San Andreas Fault Zone (SAFZ) is one of the most prominent features in the San Francisquito watershed, bisecting it in a northwest-southeast direction (Brabb *et al* 2000; Helley *et al* 1979). The steep, upper watershed lies southwest of the SAFZ in the northern Santa Cruz Mountains, while the more gradually sloping areas lie to the northeast. Unstable slopes and active landsliding are mostly found southwest of the SAFZ (Wentworth *et al* 1997).

The geologic formations in the upper San Francisquito watershed, southwest of the SAFZ, consist of Tertiary sedimentary rocks, primarily sandstones, mudstones and shales (Brabb *et al* 2000). The Franciscan Complex underlies the Bay foothills northeast of the SAFZ (Brabb *et al* 2000). Large areas of greenstone and graywacke, part of this Complex, underlie the southern part of the Los Trancos watershed.

The boundary or contact between the bedrock in the upper watershed and the unconsolidated materials around San Francisco Bay lies close to Alameda de Las Pulgas Road, along the Pulgas Fault ((Fio and Leighton 1994; Metzger 2002). The unconsolidated material is an alluvial apron, consisting of coalesced deposits from the tributaries draining to San Francisco Bay deposited during the Pleistocene and Holocene. It is thick near San Francisquito Creek (more than 1,000 feet) and includes lenses or layers of Bay Muds deposited during marine transgressions. San Francisquito Creek is incised into the alluvial apron deposits (Helley et al 1979).

Metzger (2002) prepared a geological profile along San Francisquito Creek downstream of Alameda de Las Pulgas Road based on well records. It shows a layer of coarse channel bed material (gravel, cobbles and boulders) extending downstream from Alameda de Las Pulgas Road as far downstream as Middlefield Road. This coarse material overlies a sandy deposit that continues under the streambed to the Palo Alto Municipal Golf Course. A thick layer of bay sediments with lenses of alluvium extends at depth beneath the sand upstream to about San Mateo Drive. These bay sediments are underlain at depth by older, more consolidated alluvium.

2.2 Surface Water Hydrology

STREAM GAGES

The "San Francisquito Creek at Stanford University (11164500)" gage, located on the Stanford Golf Course upstream of Junipero Serra Boulevard, provides the best long-term record of flow in San Francisquito Creek with measurements from 1931 to 1941 and then from 1951 to present. This gage has a watershed area of 37.5 mi^2 and measures the flow from the Santa Cruz Mountains and Bay Foothills.

The stream gages operated on San Francisquito Creek and its tributaries are summarized in Table 1.

Balance Hydrologics, Inc currently operates stations on the tributaries to San Francisquito Creek for Stanford University. Data collection from these stations began in 1997 on Corte Madera Creek at Westridge Road and in 1995 on Los Trancos Creek at Arastradero Road (Owens, Chartrand and Hecht 2002).

Crippen and Waananen (1969) report measurements on three small tributaries in the Bay Foothills, from 1959 to 1965, showing the effect of suburban development on their hydrologic regime. Their study included the Los Trancos Creek Tributary described in Table 1. They identified increases in storm and annual runoff, a more rapid response to precipitation, an increase in the occurrence of frequent floods, and a change from ephemeral to perennial flow as a result of golf course irrigation resulting from conversion of rural lands.

ANNUAL FLOWS

San Francisquito Creek has a Mediterranean climate, with warm, dry summers and mild, wet winters. Average annual precipitation varies from 15 inches at Palo Alto (Metzger 2002) to about 40 inches in the upper watershed (Rantz 1971). The Corps of Engineers (1972) estimated an average annual precipitation over the watershed of about 32 inches. Average annual flow at the Stanford University gage is 21.4 cfs, equivalent to 7.7 inches of runoff, or about 25% of average annual precipitation.

nhc *et al* (2002) extended the record of annual flows to 1899 to 2000 water years at the Stanford gage, filling missing years in the recorded flow record through correlation with nearby long-term gages. Examination of this record shows distinct periods of high and low annual flows, with the periods of high flows spaced roughly 15 to 20 years apart. Streamflow has been particularly high from 1995 to 2000; other periods of consistent high flows include 1899 to 1911 and from 1937 to 1945.

PEAK FLOWS

The flood of record on San Francisquito Creek at the Stanford University gage occurred in 1998 with a peak of 7,200 cfs. Other notable floods – those exceeding 5,000 cfs based on reconstructed records – have occurred in 1894, 1895, 1911, 1955 and 1982 (Kittleson *et al* 1996; see also Corps of Engineers 1972).

The Corps of Engineers (1972) also notes that between 1910 and 1972 San Francisquito Creek overflowed its banks eight times – in 1911, 1916, 1919, 1940, 1943, 1950, 1955 and 1958. It also overflowed its banks in 1982 and then again in 1998 (Cushing 2000). Levees and channel modifications now contain the flows that overtopped the banks earlier in the twentieth century. As described by the Corps of Engineers (1972) and Cushing (2000) overflow now mostly occurs along the lower part of the creek, downstream of Middlefield Road, during extreme floods.

The tributaries to San Francisquito Creek in the upper watershed are all deeply incised and flooding had not been reported along them as of 1972 (Corps of Engineers 1972). Note that aggradation on the fan of Corte Madera Creek at the head of Searsville Lake has now resulted in flooding along Family Farm Road and its adjacent properties (see nhc and JSA 2000).

LOW FLOWS

Low flows at the Stanford University gage typically occur in the late summer or early fall, before winter rains begin. Downstream of this gage, the channel bed over the fan deposits is effluent and low flows infiltrate to groundwater, leaving much of the streambed dry for about six months of the year (Metzger 2002). Upstream of the gage, where San Francisquito Creek flows over bedrock, streamflow losses appear to be negligible.

Most of the streamflow losses or infiltration to groundwater occurs between San Mateo Drive and Middlefield Road where San Francisquito Creek crosses the Pulgas fault. Further downstream, losses are minimal and groundwater returns may supplement stream flows near Woodland Road. Storm drains also supplement natural flow at various sites along the reach and water chemistry measurements indicate that during moderate and low flows that streamflow downstream of San Mateo Drive is a mix of natural flows from the upper watershed and urban runoff (Metzger 2002).

Crippen and Waananen (1969) noted that the small tributaries in the Bay foothills and plains were ephemeral prior to development. Irrigation and watering following urbanization have resulted in perennial flows in some small tributaries to San Francisquito Creek, maintaining lows flows when previously there were none. However, most of the steep tributaries currently appear to have intermittent flows. The general nature of streamflow in the Santa Cruz Mountains is described in a later section.

2.3 Water Management Structures

The Corps of Engineers (1972) identified four major water management structures in the San Francisquito watershed (Table 2). These four reservoirs are thought to have only a minor effect on flood flows as their volumes are not very large compared to inflows, these reservoirs are often full when large floods occur, and flood flows are diverted around some reservoirs to avoid siltation (Corps 1972). There are also a number of small reservoirs and water diversion structures in the watershed that have not been inventoried.

During spring months, several acre-feet per day (roughly less than 10 cfs) are diverted from San Francisquito Creek, just upstream of the Stanford gage, to fill Lagunita Lake and maintain its water level. After commencement ceremonies, the lake is drained and water returned to San Francisquito Creek in mid-June (Metzger 2002).

Searsville Dam is no longer operated but, in the past, flashboards were installed in the spring to store about 4.5 feet of water for irrigation; these flashboards were removed in the fall to lower winter water levels in Searsville Lake. The operation of the other reservoirs is not known. However, it is likely that water utilization, evaporation, and diversion of flow to maintain summer reservoir levels has reduced spring, summer and fall flows to some extent in the San Francisquito watershed. Considerable further analysis would be required to evaluate the extent to which natural flows have been reduced.

2.4 Groundwater Hydrology

The aquifer that underlies the San Francisquito alluvial fan is an arbitrarily defined sub-basin of the larger aquifer that extends into the Santa Clara Valley (Sokol 1964; Fio and Leighton 1994). The sub-basin beneath the fan includes both a shallow aquifer in the sandy deposits that lie beneath San Francisquito Creek and a deeper one with water bearing strata at depths greater than 200 feet below the local ground surface.

The shallow aquifer extends to depths of up to 100 feet and lies above a layer of clayey bay deposits. This aquiclude or confining bed ends near San Mateo Drive. Upstream of this point, the shallow aquifer is apparently connected to the deeper one (Sokol 1964; Metzger 2002). Water levels in the shallow aquifer are below the stream bottom, particularly upstream of San Mateo Drive where they are more than 20 feet below the ground surface. Groundwater levels may be near the streambed just downstream of Middlefield Road and then again in the tidal reach, downstream of Highway 101 and through East Palo Alto.

As discussed earlier, stream flows from San Francisquito Creek infiltrate the streambed and recharge the aquifers. Metzger (2002) estimated annual losses of about 1,000 acre-feet, with most of the loss between San Mateo Drive and Middlefield Road. This is equivalent to about 9% of the long-term mean annual flow. Sokol (1964) estimated slightly smaller losses by comparing flows at the various gaging stations that operated on San Francisquito Creek in the 1930s (see Table 1). Seepage from Lake Lagunita, infiltration of runoff from the foothills, over-irrigation, and leakage from water distribution and stormwater systems also contribute to the aquifer recharge.

Metzger (2002), Metzger and Fio (1997), and Fio and Leighton (1994) indicate that groundwater pumping was an important water source for communities on the San Francisquito fan until the mid-1960s, when purchased water became the primary source. Groundwater still remains a significant water source in some communities on the San Francisquito fan, such as Atherton.

Groundwater exploitation prior to the mid-1960s resulted in lowered groundwater elevations in Palo Alto, Menlo Park and Atherton (Metzger 2002), movement of saline water inland from San Francisco Bay (Iwamura 1980), and land subsidence in parts of Palo Alto and East Palo Alto (Poland and Ireland 1988). Groundwater levels are thought to have recovered since the mid-1960s. However, groundwater elevation data are limited near San Francisquito Creek and it is difficult to assess whether elevations are now similar to those at the end of the nineteenth century or whether they remain depressed. The limited information available (see maps in Fio and Leighton 1994) suggests that historic ground water elevations were below the local streambed on the upper part of the fan, resulting in similar losses of streamflow to groundwater to those observed now.

Groundwater elevations may have been closer to the streambed along the lower part of San Francisquito Creek, resulting in more frequent surface flows in the past than occur there now. Note that streambed incision in the upper end of San Francisquito Creek and aggradation along the lower reaches over the past century may have also affected the extent of infiltration and groundwater influence along San Francisquito Creek.

Much less is known of groundwater levels in the upper watershed. Crippen and Waananen (1969) note that groundwater elevations are typically well below the surface in small tributaries to San Francisquito Creek in the Bay Foothills, although they may rise to streambed levels following intense winter storms. Little is known of the groundwater conditions in the upper watershed. Here, shallow soils over bedrock on the valley slopes limit the extent of groundwater storage and its influence on streamflow. However, groundwater may be an important component of streamflow along the valleys of the San Andreas Fault Zone where deep alluvial deposits may store considerable volumes of water.

2.5 Sediment Transport

Certainly, the longest record of sediment yield is from deposition in Searsville Lake by Corte Madera, Sausal, and Alambique Creeks. Repeated reservoir surveys provide average sediment deposition from 1892 to 1913; 1913 to 1929; 1929 to 1946; 1946 to 1995; and from 1995 to 2000 (nhc *et al* 2002). Note that deposition in the reservoir underestimates total sediment transport from the Searsville watershed. This occurs for two reasons. First, the finest grain sizes are carried over Searsville Dam to San Francisquito Creek so they are not included in the total, and second, coarse sediment that has accumulated on the fans of Corte Madera, Sausal and Martin Creeks upstream of the reservoir has not been surveyed, except between 1995 and 2000 (nhc *et al* 2002). The sediment that passes over the dam amounts to about 10% of the incoming load; adjustments for deposition on fans at the head of the lake can only be prepared for the most recent period.

Table 3 summarizes deposition volumes and calculated denudation rates in the Searsville Lake watershed and provides estimated transport for Corte Madera and for the other tributaries to Searsville Lake. The pattern of sediment transport is similar to that of annual flows. Very large volumes were transported during the early part of the twentieth century and from 1995 to 2000; sediment transport seems to have been at a lower average rate in the intervening years. Long-term average denudation rates are reasonably consistent with the long-term uplift rate in the northern Santa Cruz Mountains.

Landslides, debris flows, bank erosion, and channel incision in the Santa Cruz Mountains appear to contribute most of the sediment that is carried to Searsville Lake. These sources are active infrequently, particularly during severe storms and earthquakes.

Brown and Jackson (1973) report on a suspended sediment sampling program at the Stanford gage for the period from 1962-1969. Annual loads at the station can be assumed to be nearly entirely from Los Trancos and Bear Creeks and they provide an indication of historic suspended (fine) loads from these two subwatersheds. Additional measurements were collected at this gauge during the 1998 water year to compare to the previous sediment-rating curve (nhc *et al* 2002).

Table 3 summarizes annual suspended loads reported by Brown and Jackson and calculated denudation rates in Bear and Los Trancos watersheds. Denudation rates on Los Trancos and Bear watersheds are highly variable from year to year but average – reflecting the occurrence of landslides and channel erosion during large storms – but average much lower than observed in Corte Madera Creek watershed. This is consistent with the patterns of landsliding and other sediment sources in the Santa Cruz Mountains.

3. WATERSHED CHARACTERISTICS

3.1 Background

The watershed boundaries developed by the Geologic Survey's Western Region Geoscience Center have been used for this study as the basis for describing watershed characteristics. Because these watershed boundaries provide the framework for an extensive GIS database that inventories physical and social features within the watershed (USGS 2003), it was determined that using the same boundaries for this study would facilitate incorporating new information into the existing database. The boundaries delineate major subwatersheds for the large tributaries to San Francisquito Creek and further sub-divide the tributary subwatersheds into sub-subwatersheds. The San Francisquito watershed is composed of 10 subwatersheds: San Francisquito, Corte Madera, Los Trancos, Alambique, Martin, Sausal, Westridge, Bear, Bear Gulch, and West Union Creeks. Additionally, for the purposes of this analysis, the subwatersheds were further divided into sub-subwatersheds based on hydrologic characteristics. Table 4 summarizes the size and stream lengths of the subwatersheds and sub-subwatersheds within this system.

3.2 Reach Division and Description

After a review of existing stream classification systems, it was determined that the Montgomery and Buffington (1993) stream classification system, referred to here as the Montgomery-Buffington method, would best characterize and classify the stream morphology of the San Francisquito Watershed. The Montgomery-Buffington method was selected over other potential classification systems because of its suitability to the project area and the project needs. Key advantages of the Montgomery-Buffington method are:

- The Montgomery-Buffington method was developed for mountainous watersheds of the Pacific Coastal Ecoregion, an area that covers approximately 2300 miles of coastal watersheds along the western edge of North America from the Santa Cruz Mountains to Anchorage, Alaska.
- The Montgomery-Buffington method was designed for use in forested mountain watersheds where there is a significant large woody debris (LWD) component to stream bed morphology.
- The Montgomery-Buffington method can be applied at a reconnaissance level using aerial photographs and topographic maps. Although preferable, field surveys are not required for application to watersheds where only limited physical data are available.
- The Montgromery-Buffington method is a process-based approach designed for application in watershed-scale studies that assess channel form and response to natural and human disturbance.

MONTGOMERY-BUFFINGTON METHOD DESCRIPTION

The Montgomery-Buffington method uses a process-based, watershed-scale approach to characterize changes in channel morphology, sediment transport dynamics, and response potential of streams to natural and human disturbance. A process-based approach identifies the relationship between channel morphology and transport processes, including inflowing water and sediment, hydraulic conditions, and spatial and temporal changes in local factors which affect channel form such as land use, riparian cover, or instream bedrock controls.

The Montgomery-Buffington method identifies three main morphologic scales; the watershed, the valley segment, and the channel reach. Watersheds are divided into two basic categories; hillslopes and valley segments. Valley segments are located along the drainage network and are divided into *colluvial*[1], *bedrock*, and *alluvial*[2] types. *Colluvial* valley segments exist predominantly in the upper watershed and are often dominated by debris flow and landslide processes. Sediment supply exceeds sediment transport capacity and soil creep, tree throw, and slope instability are primary ways sediment is introduced into the channel network. Sediment in colluvial channel beds is commonly less sorted than in downslope channels. In contrast, sediment transport capacity exceeds supply in *bedrock* valley segments, resulting in the transport of available material through the reach, exposing bedrock, or mostly bedrock, along the channel. *Alluvial* valley segments are those where streams and rivers flow through alluvium, characterized by unconsolidated fluvially deposited sediment.

Alluvial and colluvial valley segments are characterized by a range of stream types that, in the Pacific Coastal Ecoregion, commonly present as a sequential transition of fluvial styles with distance downstream (Figure 1). The Montgomery-Buffington method proposes that each stream type represents a stable morphology for the given sediment supply and available sediment transport capacity of the reach. Table 5 provides a brief description of each stream type. Note that gradient divisions between stream types in Table 5 are not absolute. Rather, transitions between types are gradual such that some reaches may exhibit features of multiple stream types.

CLASSIFICATION OF PHYSICAL STREAM CHARACTERISTICS

The Montgomery-Buffington Method was used to classify stream types in the San Francisquito watershed. Although field inspection is the preferred approach for channel classification, watershed size and time constraints did not allow us to visually inspect all stream channels in the watershed. Instead, a reconnaissance-level classification was conducted using several data sources, namely: stream slope data collected from a digital elevation model (DEM), air photos, field inspections of Corte Madera Creek conducted by nhc for this study, and reported stream observations from other authors. Frey (2001) documented river morphology on all streams draining into Searsville Lake; Smith and Harden (2001) walked and reported observations on major streams draining the Bear Creek subwatershed during an inspection of obstructions to fish passage; Royston Hanamoto Alley and Abey (2000) compiled a detailed assessment of geomorphic conditions along San Francisquito Creek from Junipero Serra Blvd. to Highway 101; and nhc *et al* (2002) assessed geomorphic conditions on San Francisquito Creek downstream of Searsville Dam. No field inspections of streams in the Los Trancos Creek watershed were identified in the available literature.

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[1] Colluvium - a general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity (Dictionary of Geological Terms, 1984)

[2] Alluvium - a general term for detrital deposits made by streams on river beds, flood plains, and alluvial fans (Dictionary of Geological Terms, 1984)

Using the DEM information in a GIS, streams in the San Francisquito watershed were divided into segments based on the slope ranges identified in Figure 1. Predicted stream types from the Montgomery-Buffington method were then assigned to each slope class to provide a preliminary assessment of stream types in the watershed (Figure 2). Note that the legend excludes Regime ($S < 0.001$) and Bedrock ($0.30 > S > 0.001$) stream types. The only area to exhibit a Regime channel morphology is located in the estuary of San Francisquito Creek, downstream of Highway 101 where the creek is tidal, whereas bedrock stream types are possible in all slope environments and must be validated by field inspection. Note that slopes in Figure 2 are averaged, typically over several hundred meters depending on slope variability, and represent a typical slope for stream segments in each sub-subwatershed.

The validity of predicted results from the Montgomery-Buffington method was assessed by comparison with field observations of channel reaches at the sub-subwatershed scale (Table 6). The Los Trancos subwatershed and some reaches of the Bear Creek subwatershed are excluded from Table 6 due to a lack of field inspection reports for these areas. Predicted and observed stream types in Table 6 are representative of what is typical for each sub-subwatershed. Some stream sections may and likely do exhibit variations that are atypical and differ from the stream types identified in Table 6.

Examination of Table 6 shows that, although there are some differences, predicted stream types from the Montgomery-Buffington method show good correlation with field observations. Predicted stream types were observed in 26 of the 29 sub-subwatersheds; however, more than just the predicted stream type(s) was observed in 16 of these 26 sub-subwatersheds. Thus, observed stream types were often more varied than what was predicted. In all of these cases, additional observed stream types were one class above or below the predicted type. This is not unusual given that slopes were averaged along stream segments in each sub-subwatersheds. Consequently, some stream reaches exhibit slopes and therefore stream types that are greater or less than the average.

There were three occurrences where some or all of the predicted stream types were not observed, namely: sub-subwatersheds CM-12, BG-3, and CM-6 (Table 6). In each case, a colluvial stream type was either predicted or observed. In CM-12 and CM-6, cascade stream types were predicted for these sub-subwatersheds whereas colluvial channels were observed due to abundant landslide activity. In sub-subwatershed BG-3 a colluvial stream type was predicted but not observed. This is due to an omission. The steep tributary stream to Bear Gulch associated with the colluvial stream type in Figure 2 was omitted from the field inspection and thus could not be compared with the predicted type (Table 6).

4. LAND USE

4.1 Background

Of the approximately 27,400 acres of the San Francisquito watershed, approximately 8,798 acres are protected by public agencies, property easements, or private land trusts (32.1%), providing a natural feel within much of the watershed. The west side of the watershed is largely unpopulated, consisting primarily of forest and grasslands. The headwaters of the watershed originate in the Santa Cruz mountains within the western side of the watershed, and drain into Los Trancos Creek. Corte Madera Creek and West Union Creek also largely drain protected areas that support forested habitats. The lower watershed is highly urbanized, and supports expansive areas of residential and commercial development. Although development is prevalent when compared to the western portion of the watershed, large, contiguous areas of open space, including forest, rangeland and agricultural areas, are interspersed throughout the urban land uses, complementing the undeveloped, open nature of much of the watershed.

4.2 Existing Conditions

To examine the existing land uses throughout the watershed, a number of land use classification systems were reviewed in order to identify the system that would best classify the watershed into land use categories for analysis. Because the Santa Clara and San Mateo County general plans use different classification system, it was necessary to use a classification system that was contiguous throughout the entire watershed. In addition, the Department of Water Resources land use classification system was reviewed, but because of the lack of detail it was determined that this system did not meet the needs of the project. It was determined that the system developed by the Association of Bay Area Governments (ABAG) in 1995 provided the most comprehensive and thorough system for describing the watershed. This system was developed in 1995 for the entire San Francisco Bay area, including San Francisquito watershed. The spatial resolution (1 hectare) of the data provides a suitable scale for analysis of existing land use conditions throughout the watershed. ABAG updates this data set every 5 years, and identifies changes in land uses through aerial photography review and mapping at a 1:3,000 scale, followed by ground-truthing on a 1:24,000 scale basemap. In areas where access is limited, including those lands owned by public agencies, property easements, or private land trusts, the Bayareaap data, developed by the GreenInfo Network, was used supplement mapping. This information was last updated in 2001. The JPA is currently in the process of obtaining the latest set of land use data to be included in future versions of this document. For analysis purposes in this document, land use information is from the 1995 mapping effort.

Table 7 summarizes the existing land uses within the San Francisquito watershed. The dominant land uses are forest, rangeland, and residential development. As described above, the majority of forest and rangeland exist in the western portion of the watershed, while the residential development is dominant in the eastern portion of the watershed. As of this 1995 land use analysis, development within the watershed consisted of 29.6

percent residential, 5.2 percent industrial/commercial, and 65.1 percent agriculture or open space.

4.3 Historical Trends

Throughout time, the San Francisquito watershed has continued to increase in the area that supports commercial and residential development, as part of the ever-growing larger San Francisco Bay Area. Review of historic and current aerial photos and maps indicate a steady growth in area of development, particularly in the eastern portion of the watershed where the topography is more gently sloping. In conjunction with the increasing areas of development, the roadways system has continued to expand, both in size and complexity throughout the watershed. Figures 3 through 5 show the changes in both land uses and roadways from 1899 to 1948 and then to 1993. In addition, Table 8 documents the change in paved and unpaved roadways throughout the watershed from 1868 to 1999. Table 8 also includes the number intersections between roadways and streams within the watershed, showing the steady increase in stream interactions with development over time in many of the sub-watersheds.

The Santa Clara Basin Watershed Management Initiative (WMI) has also projected future residential, industrial, and commercial development within the watershed through the year 2020 based on trends over time throughout the watershed, and in the surrounding areas. Although development will continue to increase over time throughout the watershed, only 8,149 acres are available for development, leaving a substantial portion of the watershed in a relatively natural condition. The projected increase in development is shown in Table 9. Increased development directly results in changes in the area of impervious surfaces within the watershed also, changing runoff patterns, water quality, and flood capacities over time. The projected increase in impervious surfaces as a result of projected development is shown in Table 10.

5. BIOLOGICAL RESOURCES

5.1 Background

The biological resources within the San Francisquito watershed have been separated into terrestrial and aquatic species and habitat types, and are described below. These descriptions are based on a number of previous studies and databases, including the:

- "Fishes and Amphibians of the San Francisquito Creek and Matadero Creek Watersheds", completed by Stanford University in 2000,
- "Biotic Assessment of Upper Searsville Lake and the Lower Floodplain of Corte Madera Creek" completed by Standford University in 1996,
- "Juvenile Steelhead/Rainbow Trout Surveys in Los Trancos Creek", completed by David Vogel in 2002,
- "Distribution and Ecology of Stream Fishes in the San Francisco Bay Drainage" completed by R. A. Leidy in 1984,
- "Fish Survey 1992-1998, bay Area Stream Fishes, Version 1.2", completed by R. A. Leidy in 1999,
- "Adult Steelhead Passage in the Bear Creek Watershed", completed by Jerry Smith and Deborah Harden of San Jose State University,
- "Watershed Characteristics Report" completed by the Santa Clara Basin Watershed Management Initiative in 2001,
- "California Natural Diversity Database", which is on-going and managed by the California Department of Fish and Game, and,
- "California Wildlife-Habitat Relationships System and GAP Analysis Mapping", completed by the U.S. Forest Service and U.C. Santa Barbara in 1988.

5.2 Terrestrial Habitat Types

Terrestrial habitat presence and species richness was defined using the California wildlife habitat relations (WHR) based on vegetation data from the California GAP analysis. The University of California at Santa Barbara (UCSB) completed the California Gap analysis in 1988. Upland types were mapped with a minimum mapping unit (MMU) of 100 hectares (247 acres). Major wetland areas were mapped using a 40 hectare (99 acre) MMU, and smaller wetlands are encoded as attributes of larger upland polygons. The California Wildlife-Habitat Relationships System (WHR), in conjunction with digital species range maps, was applied to the vegetation map to predict the current distribution of potential habitat for each native terrestrial vertebrate species. This system was used to classify habitat types within the San Francisquito watershed because it is broad in nature, and provides a uniform system throughout the entire watershed. This system was selected for the purposes of this study because mapping encompasses the entire watershed area. Local studies, the California Department of Fish and Game Natural Diversity Database, and field verification were used to determine more specific wildlife and habitat correlations for special-status species that are know to occur, or thought to occur, within the watershed. This information is described below under the special-status species section.

A number of detailed vegetation and wildlife habitat surveys and assessments have been conducted along the project reach. These studies include: the San Francisquito Creek Riparian Habitat Project Report by the Coyote Creek Riparian Station; the San Francisquito Creek Bank Stabilization and Revegetation Master Plan Existing Conditions Report prepared by Royston, Hanamoto, Abbey and Alley; and, the Searsville Lake Sediment Impact Study: Biotic Resources Synthesis Report prepared by H.T. Harvey & Associates.

Figure 6 shows the WHR habitat classifications by subwatersheds. Acreages for each habitat type by subwatershed are shown in Table 11.

ANNUAL GRASSLAND

Annual grassland habitats are open grasslands composed primarily of annual plant species. Introduced annual grasses are the dominant plant species within this habitat throughout the watershed. This habitat type fluctuates throughout the year with rainfall levels and temperature variations, growing rapidly in the spring, dying off in the summer, and slowly growing over the fall and winter months. In addition, grazing is permitted in many portions of the watershed, keeping grasses low to the ground. Vegetation within this habitat type includes wild oats, ripgut brome, popcorn flower, true clover, Crystal Springs lessingia serpentine bunchgrass, fragrant fritillary, Franciscan onion and California poppy. Wildlife species that utilize annual grasslands include the western fence lizard, common garter snake, western rattlesnake, California ground squirrel, Botta's pocket gopher, western harvest mouse, western meadowlark, turkey vulture, and northern harrier.

COASTAL OAK WOODLAND

Coastal oak woodland habitat consists of an overstory dominated by deciduous and evergreen hardwoods with scattered conifers. The vegetation within this habitat type is dominated by coastal live oak, and also includes California bay, madrone, valley oak, blue oak, and digger pine. Typical understory plants generally consist of California blackberry, fiesta flower, miner's lettuce, robust monardella, and legenere. Wildlife species found throughout this habitat include California red-legged frog, California tiger salamander, gopher snake, western pond turtle, red-tailed hawk, western meadowlark, acorn woodpecker, northern harrier, California ground squirrel, raccoon, pallid bat, and Bay checkerspot butterfly.

CHAMISE-REDSHANK CHAPARREL

Chamise-redshank chapparrel habitat within the watershed is mature in nature, and generally consists of single layered chaparral habitat lacking a well-developed herbaceous groundcover and overstory trees. This habitat type is dominated by chamise and redshank vegetation, and supports jackrabbits, cottontail rabbits, ground squirrels, wood rats, pocket mice, and several sparrows and hawks.

MONTANE HARDWOOD

The montane hardwood habitat is mature in nature, and consists of a pronounced hardwood tree layer, with a poorly developed shrub stratum, and a sparse herbaceous layer throughout the watershed. Douglas fir, California black oak, Digger pine, knobcone pine, and coast live oak are abundant within this habitat type. The understory consists of scattered woody shrubs, including manzanita, poison-oak, and western leatherwood. Wildlife species found within this habitat include scrub jay, Steller's jay, acorn woodpecker, saltmarsh common yellowthroat, western gray squirrel, California ground squirrel, dusky-footed woodrat, western fence lizard, and western rattlesnake.

REDWOOD

The redwood habitat within the watershed consists entirely of secondary growth, creating an even-aged tree structure. Dominant vegetation within this habitat includes coast redwood, Pacific madrone, douglas fir, and California buckeye. Understory vegetation is diverse, and generally consists of deer fern, California huckleberry, California red huckleberry, coyotebush, snowbrush ceanothus, Santa Cruz manzanita and western fescue. Wildlife that are often found within this habitat type include California red-legged frog, California tiger salamander, peregrine falcon, gray squirrel, Steller's jay, and deer mouse.

URBAN

Vegetation within urban environments varies greatly depending on the level and type of development. Development types within the San Franciscquito watershed include industrial, commercial, and residential development, interspersed with open space and park areas. Street tree strips are common within the highly developed portions of the watershed. Shade trees and lawns are common in residential areas. Vegetation is dominated by ornamental species that are used for landscaping purposes within these areas. Common wildlife species found within the urban environment include house sparrow, rock dove, scrub jay, house finch, raccoon, opossum, and striped skunk.

A number of sensitive habitats are found within the urban environment as mapped by the WHR system. Within the urban areas of the watershed, a number of riparian corridors line the streams of the watershed. Tree species that occur within the riparian corridor include valley oak, coast live oak, willows, and California buckeyes. Common riparian shrubs include coffeeberry, ocean spray, and creeping snowberry. These areas provide suitable habitat for a number of sensitive species, including California red-legged frog, California tiger salamander, western pond turtle, and, within the streams, steelhead. In addition, areas of coastal salt marsh habitat are included within the urban classification towards the mouth of the watershed where San Francisquito Creek meets the San Francisco Bay. The salt marsh habitat is dominated by cordgrass, pickleweed, and salt grass. This habitat type also supports a number of sensitive species, including the Point Reyes Bird's beak, Congdon's tarplant, salt-marsh harvest mouse, black rail and California clapper rail.

5.3 Aquatic Resources

The San Francisquito watershed supports a wide variety of aquatic resources, including a central California coast steelhead run. This section provides an overview of existing conditions, historic trends and an overview of current steelhead use of the watershed.

HISTORIC TRENDS

Recent fish sampling within the San Francisquito watershed include six native species and seven nonnative species. Native fish captured included the California roach, Sacramento sucker, hitch, speckled dace, threespine stickleback, and prickly sculpin. Three additional species of native fish were present historically, but are not thought to occur within the watershed presently. These include the Sacramento perch, last collected in 1960, the squawfish, last collected in 1905, and the white prickly sculpin, of which the last capture date is unknown.

As the human population increased throughout the Santa Clara Valley in the 1940s, dramatic declines in native fish populations were observed. Within the watershed, diversions and dams have been built, and increased development and changes in land uses have changed flow patterns through channelization and implementation of flood control patterns. This has resulted in increased erosion and sedimentation, a reduction in riparian habitats, and increased flow velocities throughout the watershed. These changes have degraded fish spawning and rearing habitat, particularly in riffle habitats, and decreased water quality for aquatic insect reproduction, food sources, and overall survival. In addition, the destruction of riparian vegetation has increased water temperature through a reduction in shade, and decreased the amount of organic material and ponded areas throughout the watershed through a reduction in woody debris and rootwads. Consequently, the native fish that remain in the watershed are restricted to the more natural headwaters of the western portion of the watershed, or are tolerant to a wide range of environmental conditions. Table 12 provides an overview of native fish that have been found throughout the watershed over time through a variety of studies. In addition, Table 13 show the native fish that were historically found in the watershed, and both native and invasive fish now found throughout the watershed.

EXISTING CONDITIONS

Within the San Francisquito watershed, nonnative fish populations outnumber native fish populations in many of the subwatersheds, particularly in the eastern section of the watershed. This is due to the western section of the watershed remaining less disturbed than the eastern subwatersheds. In addition, many of the tributaries that flow from the western portion of the watershed flow from protected open spaces and natural areas. The aquatic habitat in the western portion of the watershed continues to flow through areas that are largely forested, and are bordered by high quality riparian corridors. Therefore, water temperatures remain cool, woody material remains abundant, and levels of dissolved oxygen in the water remain high. Riffles in this area provide spawning habitat for many fish, well-oxygenated water for juveniles, and habitat for aquatic insects that provide a healthy food source for a variety of fish.

Within the eastern portion of the San Francisquito watershed, two small reservoirs have been constructed that block the upstream migration of fish. Reservoirs also alter flowing water habitats by creating lacustrine conditions that are static in nature. Reservoirs are often higher in temperature, lower in dissolved oxygen, and calmer than the flowing streams that they replaced. These altered environmental conditions are often more suitable for non-native fish than existing native populations. The introduction of nonnative fish populations often results from stocking waterways with fish for recreational fishing enhancement, introduction of species that control mosquito populations, pet releases, or accidental introductions. Introduced species commonly thrive in their new environments due to lack of natural predators and, thus, have a competitive edge over native fish populations.

STEELHEAD POPULATIONS

Portions of the San Francisquito watershed support a stable steelhead population. Because much of the watershed is located within steep terrain, or within lands that have been protected, high quality habitat has remained throughout the Los Trancos and Bear Creek subwatersheds. In addition, San Francisquito Creek, downstream of Searsville Dam through the Lagunita Diversion, provides quality steelhead habitat. Downstream of this area, the quality of steelhead habitat diminishes greatly. However, high sedimentation and erosion levels throughout the San Francisquito watershed associated with development and human disturbance greatly constrain aquatic habitat for steelhead spawning and rearing. In addition, flood control infrastructure and roadways have contributed to the formation of flow barriers for steelhead migration throughout the watershed, described below under the passage and barriers section. As development continues in the eastern portion of the watershed, efforts must be made to preserve the existing passageway to preserve the existing downmigrating juvenile steelhead and upmigrating adult steelhead.

STEELHEAD PASSAGE BARRIERS

A number of steelhead passage barriers exist throughout the San Francisquito watershed. These barriers include physical barriers (i.e. actual physical impediments to movement) and physiological barriers to movement (such as high temperatures and increased flows). A number of these barriers have been identified through previous studies throughout the watershed. Within the Bear Creek, Bear Gulch and West Union Creek subwatersheds, stream passage barriers have been identified and ranked in severity, and recommendations for alleviating each have been provided (Smith and Harden, 2001). In addition, the San Francisquito Watershed Council Coordinated Resource Management Plan has inventoried stream passage barriers throughout the watershed, identified recommended actions, and evaluated the severity for each. Table 14 identifies these barriers, and corresponds with Figure 7, showing the location of each. In addition, Figure 8 identifies existing stream intersections with roadways and trails throughout the watershed that may present additional fish passage barriers, but have not been field verified or evaluated.

Many efforts have been made to increase fish passage throughout the watershed. In 1978, the non-functional fish ladder at the Lake Lagunita Diversion Dam was replaced with a Denil-style fishway to improve fish movement within the watershed. In addition, a fish ladder was installed in the Los Trancos Creek watershed at the Felt Lake Diversion Dam in 1995. Searsville Dam is a terminal barrier on Corte Madera Creek, in the lower portion of the watershed.

Currently, the FishNet 4C program is working to increase communication within local jurisdictions within the region of the San Francisquito watershed for counties that lie geographically within the Central California Coastal Evolutionary Significant Units (ESU) of coho salmon and steelhead trout. The program is county-based, joining San Mateo County with Santa Cruz, Monterey, Marin, Sonoma, and Mendocino counties to identify gaps in the region's fishery restoration efforts, develop restoration plans and sources of data that are compatible within the region, and increase and improve communication between local entities and state and federal regulatory agencies. Currently, the program is working on inventorying and evaluating fishery and restoration efforts in each county, reviewing and commenting on pending state and federal legislation related to fisheries issues, soliciting private and public funding to support fishery restoration efforts, participating in conferences and training programs, and meeting with and advising local government bodies issues related to fisheries resources within the region.

5.4 Special-Status Species

A number of special-status species are known to occur, or have potential to occur, throughout the San Francisquito watershed. The California Department of Fish and Game Natural Diversity Database has identified a number of known occurrences that are shown in Figure 9. This information has been supplemented through the evaluation of existing habitats throughout the watershed to determine the suitability of each to support special status species by Jones & Stokes biologists. A brief description of these species, and associated habitats, is provided below.

The mouth of the watershed meets the San Francisco bay in salt marsh habitat which provides suitable habitat for the salt marsh harvest mouse, California clapper rail, and black rail, which have all been observed within, or within the immediate vicinity of, the bottom of the watershed. Moving west through the watershed as water becomes less tidally influenced and salinity levels decrease, riparian corridors are present along many of the streams throughout the watershed. These areas provide suitable habitat for the California red-legged frog, California tiger salamander, and western pond turtle, which have all been observed within the watershed. Additionally, streams within the Bear Creek, San Francisquito and Los Trancos Creek watersheds provide suitable migration and spawning habitat for steelhead trout that have been observed in both of these areas. Throughout the watershed, a number of serpentine soil outcrops have been identified within the San Francisquito, Searsville Lake, Bear Creek, and West Union Creek sub-watersheds. This micro-habitat supports a number of special status and common wildlife and plant species that have been observed at these areas, including the Bay checkerspot butterfly, serpentine bunchgrass, and Crystal Springs lessingia.

6. RIPARIAN CORRIDOR MANAGEMENT POLICIES & PROGRAMS

6.1 Overview

Riparian corridors that border streams throughout the watershed provide habitat for a number of special-status and common wildlife and plant species. These areas support a number of native tree species, including the valley oak, coast live oak, red willow, sandbar willow and California buckeye. In addition, a number of native shrub species are found within these corridors, including coffeeberry, ocean spray and creeping snowberry. In addition, riparian corridors provide food and habitat for wildlife species, minimize erosion, sedimentation and runoff into local waterbodies, increase the flood capacity of local waterbodies, and add to the aesthetic, natural surroundings within the watershed. In order to preserve the diversity of wildlife and plant species throughout the watershed as development continues throughout the watershed, it is essential to continue to study and protect these areas.

The WMI study mapped riparian corridors throughout the San Francisquito watershed. The study used the definition of riparian corridors earlier defined in the City of San Jose's Riparian Restoration Action Plan, completed in 1999. This definition states "...any defined stream channels including the area up to the bankfull flow line, as well as all riparian (streamside) vegetation in contiguous adjacent uplands. Characteristic woody riparian vegetation species could include (but are not limited to): willow, alder, box alder, Fremont cottonwood, bigleaf maple, western sycamore and oaks. Stream channels include all perennial and intermittent streams shown as a solid or dashed blue line on USGS topographic maps, and ephemeral streams or arroyos with well-defined channels and some evidence of scour or deposition". This mapping was then overlaid with the ABAG 1995 land use data, described above under the *Land Use* section, to determine land uses throughout the watershed within riparian corridors. Table 15 shows the results of this analysis. As can be seen from this table, a large area of riparian corridors are protected and support natural land uses, including wetlands, forest, rangleland and freshwater habitats. In contrast, a nearly equal area of riparian habitat is located in residential, urban recreation, agricultural and urban land uses. For this reason, a number of studies and policies have been developed local government agencies to guide future planning and development near these sensitive areas, which are described below.

Additional riparian mapping has been completed for the San Francisquito Creek portion of the watershed, completed as part of the San Mateo Countywide Stormwater Pollution Prevention Program (Bernhard, et. Al, 1999). Because this mapping was limited to a small portion of the watershed, the analysis for this report is focused on the broader mapping effort that was undergone as part of the WMI study.

6.2 Local Land Use and Development Policies

San Francisquito Creek, which lies in the lower end of the watershed, is located within the District's Lower Peninsula Flood Control Zone and San Mateo County's San Francisquito Creek Flood Control Zone. Because recent flood events have occurred in 1955, 1958, 1982, 1995, and 1998, efforts have been made to improve flooding and bank erosion within this creek system. Efforts have included protecting existing riparian vegetation, whenever possible, to improve flood capacities and bank erosion within the waterway. In contrast to this, areas have been lined with sacked concrete, or protected with berms and low floodwalls. Efforts to implement flood control measures that include natural components, including enhancing or restoring riparian vegetation, are also being looked at and implemented throughout the waterway.

Additionally, a CRMP process has been under way since 1993 for the entire San Francisquito watershed. This process includes over 30 organizations that are dedicated to preserving the natural resources, and in particular riparian corridors, throughout the watershed. A CRMP Draft Management Plan and Reconnaissance Investigation Report of the watershed that identified alternatives for addressing flood and erosion issues throughout the watershed were completed. This process is continuing as local fisheries, wildlife resources, and land uses are identified and studies throughout the watershed.

While studies continue to be performed throughout the watershed to determine future actions that will enhance and protect riparian corridors throughout the watershed, local policies that have been developed by both Santa Clara and San Mateo counties continue to be implemented. These policies guide local development, recreation, and flood control planning to both support the missions of the counties and protect the sensitive riparian corridors throughout the watershed. These policies have been summarized in Table 16.

6.3 Stream Maintenance and Management

OVERVIEW

The management and maintenance of the local drainage systems within the San Francisquito watershed is the responsibility of several local agencies including the District, the San Mateo County Flood Management District, and the cities of Palo Alto, Menlo Park, and East Palo Alto. In 1999 these entities formed the San Francisquito Creek Joint Powers Authority (JPA) to coordinate flood protection, creek maintenance, and habitat protection and restoration activities along the creek and within the watershed.

A variety of flood management and drainage facilities are found within the watershed including storm drains that convey storm water runoff from adjacent developed areas, and reservoirs such as Searsville Lake that provide incidental flood storage and management. For example, Metzger (2002) identified and mapped 12 storm drains with diameters greater than 30 inches along San Francisquito Creek between Junipero Serra Boulevard and the Palo Alto Municipal Golf Course. Additionally, the lower main stem of San Francisquito Creek has been modified (i.e., concrete and/or rock lined, leveed) in areas to prevent bank erosion/failure, increase the ability of the creek channel to convey floodwater, and to reduce the threat of flooding to adjacent developed areas. Management and maintenance of these facilities is the responsibility of the city public works departments and the District. Specific information on routine stream maintenance activities conducted by the District is provided below.

SANTA CLARA VALLEY WATER DISTRICT STREAM MAINTENANCE PROGRAM

The District is a special purpose governmental agency responsible for providing water supply and flood protection for Santa Clara County in an environmentally responsible manner. The District manages streams, canals, reservoirs, dams, pipelines, groundwater percolation facilities, and water treatment plants throughout the county. The District's jurisdiction on a stream begins at the point where 320 acres (1/2 square mile) of watershed drain to the stream, and continues downstream to San Francisco Bay.

The District routinely conducts maintenance activities (e.g., sediment and vegetation removal, bank protection) on streams and canals within its jurisdiction to meet flood protection and water supply mandates, provide access and flood protection, and protect property. Recently, the District developed the Stream Maintenance Program (SMP), which was approved by regulatory and resource agencies, to provide specific programs to effectively implement individual routine stream maintenance projects. The SMP specifies procedures for maintenance design, field operations and Best Management Practices (BMPs), and includes a regional mitigation program to mitigate cumulative wetland and riparian impacts (SCVWD 2001).

Routine stream maintenance activities addressed in the SMP include:

- **Sediment Removal.** The District typically removes sediment in areas where sediment deposition has: 1) reduced flood conveyance capacity; 2) impeded function of facilities and/or structures (e.g., flap gates, culverts); or 3) impede fish passage and/or access to fish passage structures.
- **Vegetation Management.** The District typically removes vegetation in and adjacent to streams and canals to: 1) maintain flood conveyance capacity; 2) maintain water conveyance for supply purposes; 3) reduce fuel loads on adjacent banks to meet local fire code requirements; and 4) control invasive nonnative vegetation. Specific vegetation management activities conducted the District are based on site-specific environmental conditions, but generally include mowing, discing, hand clearing, or herbicide application.
- **Bank Protection.** Bank protection activities are typically conducted by the District to repair eroding stream banks or to implement preventative erosion protection. The District implements bank protection in areas where erosion and bank failure could: 1) cause significant property damage; 2) pose a public safety concern; 3) negatively affect transportation; 4) negatively affect beneficial use of surface water; or 5) negatively affects riparian habitat. Bank protection measures implemented by the District are based on site-specific conditions and range from the installation of "hard" structures (e.g., rock, concrete, sack concrete, gabion baskets) to the use of "soft" structures (e.g., brush mattresses, root wads, crib walls).

Within the San Francisquito watershed, stream maintenance activities routinely conducted by the District are limited to the main stem of San Francisquito Creek and primarily include vegetation removal and herbicide application.

6.4 Non-Native Species Control

Because nonnative species dominate much of the watershed, particularly in the lower portion of the watershed, a number of plans and policies have been developed by local entities to control further invasion by these species. Invasive, nonnative plant species have come to dominate many of the riparian corridors throughout the watershed. These include blue gum eucalyptus, acacia, giant reed, fennel, periwinkle, English ivy, French broom, black locust, Algerian ivy and Cape ivy. In order to control these species, the CRMP process have produced the *Streamside Planting Guide for San Mateo and Santa Clara County Streams* to guide local landowners with planting selection, highlighting the benefits of incorporating native species into local landscapes. In addition, the District routinely removes non-native vegetation, in conjunction with the SMP.

6.5 Designated Watershed Beneficial Uses

In consultation with state and local government entities, the Regional Water Quality Control Board designates existing and potential beneficial land uses for waterbodies within the San Francisco Bay area. These beneficial uses were identified and defined in the 1995 Water Quality Control Plan for the San Francisco Bay Basin (basin plan). Within the San Francisquito watershed, beneficial uses have been identified for San Francisquito Creek, Searsville Lake, and Felt Lake. Table 17 summarizes the beneficial land uses that have been identified for these watersbodies. Definitions and objectives for each land use, taken from the basin plan, are described below.

AGRICULTURAL SUPPLY (AGR)

The definition of agricultural supply states "Uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing." The objectives for this standard are to set limits for soluble salt accumulation, chemical composition changes in local soils, toxicity of crops, and disease transmission through the use of reclaimed water.

COLDWATER FRESHWATER HABITAT (COLD)

The definition of cold freshwater habitat states "Uses of water that support coldwater ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates". The objectives for this standard are set to protect coldwater habitats for both anadromous and local fisheries, including setting standards for temperature, toxicity, and dissolved oxygen.

FISH MIGRATION (MIGR)

The definition of fish migration states "Uses of water that support habitats necessary for migration, acclimatization between freshwater and saltwater, and protection of aquatic organisms that are temporary inhabitants of waters within the region". The objectives for this standard are set to protect anadromous fish, particularly fish passage barriers. Thermal, physical, and chemical barriers are all monitored, as well as tidal movement and river flows to ensure adequate environments for migratory fish and offspring.

WATER CONTACT RECREATION (REC-1)

The definition of water contact recreation states "Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing whitewater activities, fishing, and uses of natural hot springs". The objectives for this standard are set to protect human health (e.g. water borne disease transmission) through the control of the concentration of bacteria in water bodies, standards for taste and odor, and standards on floating material.

NON-CONTACT WATER RECREATION (REC-2)

The definition of non-contact water recreation states "Uses of water for recreational activities involving proximity to water but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities". The objectives for this standard are set to protect recreators engaging in non-water contact activities that are associated with local water bodies, and are set to protect and promote human well-being through protecting habitats and aesthetic features from odors or floating material.

FISH SPAWNING (SPWN)

The definition of fish spawning states "Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish". The objectives for this standard are to maintain and enhance water bodies that support fish spawning habitat through regulating water temperature, size distribution and organic content of sediments, water depth, and current velocity.

WARM FRESHWATER HABITAT (WARM)

The definition of warm freshwater habitat states "Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates". The objectives for this standard are to maintain warm freshwater habitats through the regulation of temperature, dissolved oxygen, pH, and turbidity within local water bodies for the protection of a variety of wildlife species, including bass, bluegill, perch, frogs, crayfish and insects.

WILDLIFE SPECIES (WILD)

The definition of wildlife species states "Uses of waters that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl". The objectives for this standard are to maintain dissolved oxygen, pH, alkalinity, salinity, turbidity, settleable material, oil, toxicants and disease organisms to protect riparian and wetland habitats that support a diverse array of wildlife species.

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Tables

Table 1: Stream Gages Operated on San Francisquito Creek and Tributaries

Gage Name	Gage Number	Period of Record	Area (mi^2)	River Mile [1]
At Searsville Dam (staff gage on spillway crest)	None	1892-1913	--	12.7
At Stanford University	11164500	1931 to 1941; 1950 to present	37.5	7.6
At Menlo Park	11165000	1931-1941	38.3	5.4
At Palo Alto	11165500	1934-36	38.4	4.6
Los Trancos Ck near Stanford University	11163000	1930-41	--	--
Los Trancos Tributary near Stanford University	11163200	1958-66	0.42	--
Los Trancos Ck at Stanford University	11163500	1930-41	7.46	--

[1] River mileage along San Francisquito Creek from Corps of Engineers (1972)

Table 2: Large Water Management Structures on San Francisquito Creek and Associated Tributaries

Structure Name	Purpose	Capacity (acre-feet)	Year Built	Operation [1]
Searsville Lake	Irrigation	About 250 [1]	1890	No longer operated; historically, flashboards installed in spring; removed in fall
Felt Lake	Irrigation	1,000	1930	Not known
Lagunita Lake	Recreation	360	1900	Water diverted from San Francisquito Ck in spring; drained in summer
Bear Gulch Reservoir	Domestic	660	1896	Not known

[1] Remaining capacity as of nhc *et al* (2002).

Table 3: Annual Transport Volumes and Denudation Rates in San Francisquito Watershed

A. Searsville Lake Deposition

Period	**Annual Deposition (ac-ft/yr)**	**Watershed Area (km^2)**		**Denudation Rate (mm/year)** [1]		
		Searsville	**Corte Madera**	**Total**	**Corte Madera** [2]	**Remainder**
Searsville Lake Deposition						
1892 to 1913	17.4	35.9	16.1	0.66	1.20	0.23
1913 to 1929	3.6	35.9	16.1	0.14	0.25	0.05
1929 to 1946	7.2	35.9	16.1	0.27	0.50	0.09
1946 to 1995	7.1	35.9	16.1	0.27	0.49	0.09
1995 to 2000	23.5	35.9	16.1	0.89	1.62	0.31
Average (1892 to 2000)	*9.4*	*35.9*	*16.1*	*0.36*	*0.65*	*0.12*
Total Searsville Lake and Fan Deposition						
1995 to 2000	43.4	35.9	16.1	1.49	2.69	0.51

[1] Assumes that the annual deposition represents 90% of total; 10% over dam crest (see nhc *et al* 2002)

[2] Assumes that Corte Madera provides 81% of total load (see nhc *et al* 2002)

[3] Assumes that 1 dam^3 = 1.23 acre-feet

B. Annual Suspended Load (Brown and Jackson 1973)

Period	**Annual Transport (tons)**	**Annual Volume** [4] **(ac-ft)**	**Watershed Area (km^2)** [5]	**Denudation Rate (mm/year)** [5]		
				Total	**Bear**	**Los Trancos**
1962	1,880	0.9	49.7	0.01	0.01	0.01
1963	18,700	8.6	49.7	0.14	0.15	0.13
1964	1,100	0.5	49.7	0.01	0.01	0.01
1965	10,500	4.8	49.7	0.08	0.08	0.07
1966	1,100	0.5	49.7	0.01	0.01	0.01
1967	50,600	23.2	49.7	0.38	0.40	0.35
1968	2,700	1.2	49.7	0.02	0.02	0.02
1969	34,200	15.7	49.7	0.26	0.27	0.23
Total	*120,800*					
Average Suspended Load from Bear and Los Trancos Creeks [6]						
	15,100	6.9	49.7	0.11	0.12	0.10

[4] Assumes 1.35 tons/yd^3; 1,613 yd^3/acre-foot

[5] Assumes area of Los Trancos watershed is 7.61 mi^2; that of Bear Creek is 11.57 mi^2

[6] Average suspended load is average for 1962 to 1969 at the San Francisquito Creek gauge; assumes 64% from Bear; 36% from Los Trancos (nhc *et al* 2002).

Table 4: Subwatershed and Sub-Subwatershed Acreages and Stream Lengths

Subwatershed	Sub-Subwatershed	Area (acres)	Stream Length (feet)
San Francisquito Creek	SF-1 to SF-12	8,577	82,160
	SF-1	1,047	15,450
	SF-2	1,320	0
	SF-3	833	11,012
	SF-4	648	3,020
	SF-5	372	1,866
	SF-6	243	0
	SF-7	417	0
	SF-8	999	8,597
	SF-9	496	2,859
	SF-10	247	5,976
	SF-11	1,944	32,170
	SF-12	13	1,210
Corte Madera Creek	CM-1 to CM-12	4,366	62,765
	CM-1	811	8,810
	CM-2	589	7,459
	CM-3	378	6,976
	CM-4	361	5,905
	CM-5	251	3,497
	CM-6	283	3,969
	CM-7	337	5,682
	CM-8	117	2,808
	CM-9	237	3,215
	CM-10	86	1,446
	CM-11	357	5,745
	CM-12	560	7,253
Los Trancos Creek	LT-1 to LT-7	4,870	87,229
	LT-1	405	8,771
	LT-2	555	13,049
	LT-3	534	16,010
	LT-4	649	10,225
	LT-5	920	15,138
	LT-6	1,000	14,723
	LT-7	807	9,313
Alambique Creek	AC-1	1,492	13,524
Martin Creek	MC-1	790	8,420
Sausal Creek	SC-1 to SC-6	1,547	30,225
	SC-1	381	4,798
	SC-2	409	8,151
	SC-3	138	3,414
	SC-4	231	5,938
	SC-5	280	5,864
	SC-6	107	2,060
Westridge Creek	SL-1 to SL-2	1,547	30,225
	SL-1	523	3,082
	SL-2	556	11,049
Bear Creek	BC-1 to BC-2	1,582	24,652
	BC-1	618	5,537
	BC-2	964	19,115
Bear Gulch	BG-1 to BG-3	2,250	38,643
	BG-1	428	8,838

Subwatershed	Sub-Subwatershed	Area (acres)	Stream Length (feet)
	BG-2	1,239	17,713
	BG-3	583	12,092
West Union Creek	WUC-1 to WUC-11	3,575	73,248
	WUC-1	170	1,558
	WUC-2	242	6,556
	WUC-3	139	2,215
	WUC-4	271	7,313
	WUC-5	192	3,179
	WUC-6	528	12,872
	WUC-7	281	3,895
	WUC-8	543	9,343
	WUC-9	272	7,468
	WUC-10	64	2,068
	WUC-11	875	16,781

Table 5: Summary of Valley Segment and Reach Types in the Montgomery Buffington Method

Valley Segment Type	Reach Type	Location in Watershed	Typical Slope Range	Primary Sediment Process	Instream Sediment Storage	Notes
Colluvial	Unchanneled (Hollow)	Upper	S > 0.2	Supply	N/A	Hollows are located in the uppermost sections of the drainage network. There is insufficient flow to form a channel but sediment accumulates in hollows over years or decades and, during infrequent large storm or seismic events, mass wasting processes such as a debris flow and landslides convey this sediment into the drainage network. The cycle begins again with the hollow gradually refilling with sediment.
Colluvial	Channeled	Upper / Middle	S > 0.2	Supply	High	These stream channels characterize the uppermost streams in a watershed. Colluvial processes (slope failure) dominate sediment production and channel morphology in these reaches; landslides, debris flows, and soil creep are common. Sediment supply is abundant and sediment throughput is transport limited. Bed material is typically unsorted, containing abundant fine-grained material due to limited stream flows.
Alluvial	Cascade	Upper	0.3 > S > 0.1	Transport	Very Low	Cascade channels are very steep and exhibit very coarse bed material (up to boulder sizes). Higher stream flows in these reaches appear as white-water, tumbling around larger boulders and cobbles. Sediment storage is very limited and restricted to low-velocity areas in small pools or behind debris jams. These channels can maintain their configuration for decades, until very large storms re-mobilize the stream bed.
Alluvial	Step-Pool	Middle	0.1 > S > 0.03	Transport	Low / Medium	Step-pool channels exhibit alternating pools and steps (steep, often vertical, drops usually located near a bed control such as a very large boulder or a debris jam). Steps typically contain very coarse bed material whereas pools allow finer material to accumulate, providing some sediment storage.
Alluvial	Plane-Bed	Middle	0.03 > S > 0.01	Transport	Low / Medium	Plane-bed channels exhibit a relatively flat bed that lacks significant variability and has few bedforms. Occasional steps, pools, or rapids may form but are infrequent or absent. Bed material is typically coarse and the bed is armored. Plane-bed channels may be either supply or transport limited.
Alluvial	Pool-Riffle	Middle / Lower	0.02 > S 0.001	Transport / Deposition	Medium / High	Pool-riffle channels exhibit significant morphologic variability. The bed alternates between steeper (riffle) sections with coarse bed material to shallower sloping pool sections where fine sediments accumulate and are stored until the next high flow. Instream bars are regularly observed and act as additional sediment storage sites. Pool-riffle channels are considered to be transport limited during flood flows.
Alluvial	Regime	Lower	S < 0.001	Deposition	High	Regime channels are characterized by low-slope environments and predominantly sand bed material. Channel roughness is low and sediment is transport limited at all flow stages.
Bedrock	Bedrock	Upper / Middle	0.30 > S > 0.001	Transport	Low	Bedrock channels are largely devoid of bed material. They have high transport capacities and, other than local pockets of sediment accumulation, are scoured to bedrock of all available sediment.

Table 6. Comparison of Results from Montgomery Buffington Method and Field Observations

Sub-Subwatershed	Location in Watershed	Average Stream Slope (%)	Predicted Reach Type(s)	Observed Reach Type(s)	Field Observations
CM-1	Middle	1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	(CM-1 & CM-2) The creek exhibits pool-riffle-run bed morphology and is entrenched. Bank erosion is less than in areas upstream, caused in part by gabions and concrete walls that reduce erosion. Landslides average 2.5 per stream kilometer and there no major debris jams. Channel aggradation increases downstream toward Searsville Lake. (Source: this study; Frey 2001)
CM-2	Middle	2 - 3	Plane-Bed	Step-Pool Plane-Bed Pool-Riffle	
CM-3	Upper	10 - 20	Cascade	Step-Pool Cascade Colluvial Bedrock	The gulch is very steep and confined by steep side slopes. Many areas of bedrock outcrop along the bed. The gulch exhibits a step-pool morphology in its downstream section whereas bedrock, colluvial, and cascade reaches are reported upstream. Boulders and bedrock outcrops are prominent influences on stream morphology. (Source: this study; Frey 2001)
CM-4	Upper	10 - 20	Cascade	Step-Pool Cascade Colluvial Bedrock	Jones Gulch is similar to Hamms Gulch. Bedrock controls are common and some sections of the gulch exhibit bedrock reaches where the creek has carved a canyon into rock and polished it clean of sediment. (Source: this study; Frey 2001)
CM-5	Upper	3 - 10	Step-Pool	Pool-Riffle Plane-Bed Step-Pool	The creek is entrenched and exhibits step-pool and pool-riffle-run bed morphology. The stream bed is very coarse, boulders and rock outcrops are prominent influences on channel morphology and restrict bank erosion. Small sections of floodplain are observed. (Source: this study; Frey 2001)
CM-6	Upper	10 - 20	Cascade	Colluvium Bedrock	The creek flows largely on bedrock above 1240 ft elevation whereas the reach is colluvial downstream. A large debris flow is observed at the mouth of the creek. Active and abundant erosion is a prominent feature along the creek, particularly below 1240 ft elevation. Landslides are very common, about 35 per stream kilometer. (Source: this study; Frey 2001)
CM-7	Upper	3 - 10	Step-Pool	Step-Pool	The creek is entrenched and exhibits a step-pool morphology. Occasional small gravel bars are observed as well as small areas of floodpain. Many areas of unweathered bedrock appear along the banks, preventing erosion. About 5 landslides and 7 debris jams are observed per stream kilometer, less than areas upstream. (Source: this study; Frey 2001)
CM-8	Upper	10 - 20	Cascade	N/A	Available field inspections have only examined the mouth of this gulch. Reports state that it appeared to be stable, have low bank erosion, and was not a major sediment contributor to the watershed. (Source: Frey 2001)

Sub-Subwatershed	Location in Watershed	Average Stream Slope (%)	Predicted Reach Type(s)	Observed Reach Type(s)	Field Observations
CM-9	Upper	20 - 30	Cascade Colluvial	Step-Pool Cascade	This creek exhibits a cascade morphology above 1400 ft elevation followed by a step-pool morphology downstream. Little active erosion is observed in the cascade reach whereas significant erosion of high banks is observed in the step-pool reach. About 16 landslides and 15 debris jams are observed per stream kilometer. (Source: Frey 2001)
CM-10	Upper	3 - 10	Step-Pool	Step-Pool	The creek is entrenched and exhibits a step-pool morphology with some small areas of floodplain. Small lateral bars are occasionally observed along the channel bed. Bedrock is commonly observed along the channel banks, reducing bank erosion. Landslides and debris jams are less frequent than upstream reaches, about 5 landslides 7 debris jams per stream kilometer. (Source: this study; Frey 2001)
CM-11	Upper	10 - 20	Cascade	Cascade Colluvial Bedrock	The creek exhibits a bedrock and colluvial morphology above the 1600 ft elevation with extensive bedrock control along the bed; bank erosion is light to moderate. From 1600 ft elevation to 1300 ft, resistant bedrock creates a cascade morphology. Below 1300 ft steep sideslopes and shallow landslides contribute large volumes of sediment to the channel and it maintains a colluvial morphology with about 9 debris jams per stream kilometer. Shallow landslides occur frequently, about 28 per stream kilometer. (Source: Frey 2001)
CM-12	Upper	10 - 20	Cascade	Colluvial	Frequent landsliding, about 29 per stream kilometer, dominates the steep sideslopes and stream morphology of this colluvial channel environment. The channel is aggraded in many areas with landslide material. Bedrock outcrops are very infrequent. (Source: this study; Frey 2001)
BC-1	Middle	<1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	Pool-Riffle morphology is observed throughout this reach. Larger pools exhibit silty bed material. The channel is entrenched in many areas but the banks are relatively stable. (Source: Smith and Harden 2001)
BG-1	Middle	<1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	Pool-Riffle morphology is observed throughout this reach. (Source: Smith and Harden 2001)
BG-2	Upper	3 - 20	Step-Pool Cascade	Step-Pool Cascade	A step-pool morphology with some cascade reaches are observed in this reach. Cobbles and coarse gravels are the dominant bed material. Much of the channel is deeply entrenched. (Source: Smith and Harden 2001)
BG-3	Upper	10 - 30	Cascade Colluvial	Step-Pool Cascade	A step-pool morphology with some cascade reaches are observed on the Bear Gulch main stem. The reach is described as steep, boulder channel. No observations are available for side channels in this sub-subwatershed (Source: Smith and Harden)
WUC-1	Upper	<1	Pool-Riffle	Pool-Riffle Plane-Bed	Pool-Riffle-Run morphology is observed throughout this reach. Silt is commonly observed at the bottom of larger pools. (Source: Smith and Harden 2001)
WUC-3	Upper	1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	Pool-Riffle-Run morphology is observed throughout this reach. Silt is commonly observed at the bottom of larger pools. (Source: Smith and Harden 2001)

Sub-Subwatershed	Location in Watershed	Average Stream Slope (%)	Predicted Reach Type(s)	Observed Reach Type(s)	Field Observations
WUC-5	Upper	1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	Pool-Riffle-Run morphology is observed throughout this reach. Silt is not commonly observed in pools. (Source: Smith and Harden 2001)
WUC-6	Upper	3 - 20	Step-Pool Cascade	Step-Pool Cascade	This reach is steep and deeply entrenched. Bed material consists largely of cobbles and boulders. (Source: Smith and Harden 2001)
WUC-7	Upper	2 - 10	Plane-Bed Step-Pool	Plane-Bed Step-Pool	A descriptions consistent with Step-Pool and Plane-Bed channel morphology are given for this reach. Upstream sections are steeper than downstream areas and exhibit smaller and less frequent pools. (Source: Smith and Harden 2001)
WUC-8	Upper	10 - 20	Cascade	Step-Pool Cascade	A description consistent with Step-Pool and Cascade morphology is given for this reach. This reach is very steep and exhibits logjams and falls in steeper sections. (Source: Smith and Harden 2001)
WUC-10	Upper	1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed	Pool-Riffle-Run morphology is observed throughout this reach. Silt is commonly observed at the bottom of larger pools. (Source: Smith and Harden 2001)
SF-1	Lower	<<1	Pool-Riffle Regime	Regime Pool-Riffle Plane-Bed	Regime morphology is observed downstream of Highway 101. The channel is tidally influenced, very low in slope, and exhibits a sandy bed. Upstream of Highway 101 pool-riffle-run morphology with few riffles is observed within a confined and entrenched channel cross-section. (Source: nhc *et al* 2002; RHAA 2000)
SF-3	Lower	<1	Pool-Riffle	Pool-Riffle Plane-Bed	Pool-riffle-run morphology with few riffles is observed within a confined and deeply entrenched channel cross-section. Instream sand and gravel bars are frequently observed. (Source: nhc *et al* 2002; RHAA 2000)
SF-4	Lower	<1	Pool-Riffle	Pool-Riffle Plane-Bed	Pool-riffle-run morphology is observed within a confined and deeply entrenched channel cross-section. Instream sand and gravel bars are frequently observed. (Source: nhc *et al* 2002; RHAA 2000)
SF-9	Lower	<1	Pool-Riffle	Pool-Riffle Plane-Bed	Pool-riffle-run morphology is observed within a confined and deeply entrenched channel cross-section. Instream sand and gravel bars are frequently observed. (Source: nhc *et al* 2002; RHAA 2000)
SF-10	Middle	<1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed Bedrock	Pool-riffle-run morphology is observed within a confined and deeply entrenched channel cross-section. Bedrock appears irregularly along the bed and lower banks and is a dominant control on channel morphology. (Source: nhc *et al* 2002)
SF-11	Middle	<1 - 2	Pool-Riffle Plane-Bed	Pool-Riffle Plane-Bed Bedrock	Pool-riffle-run morphology is observed within a confined and deeply entrenched channel cross-section. Bedrock is prominent along the bed and lower 5 ft of both banks and is a dominant control on channel morphology. Most flows do not rise above the bedrock contact. (Source: nhc *et al* 2002)
SF-12	Middle	1 - 10	Pool-Riffle Plane-Bed Step-Pool	Pool-Riffle Plane-Bed Step-Pool Bedrock	The bed is armoured downstream of the dam and exhibits a step-pool morphology before transitioning to a pool-riffle-run morphology further downstream. The channel is confined and deeply entrenched. Bedrock is prominent along the bed and lower 5 ft of both banks and is a dominant control on channel morphology. Most flows do not rise above the bedrock contact. (Source: nhc *et al* 2002)

Table 7: Acreage of Existing Land Uses for the San Francisquito Watershed

Land Uses	**Acreage**
Residential, 4 or more DU/acre	2,027
Residential, 1 to 3 DU/acre	6,074
Residential, 1 DU/2 to 5 acres	25
Commercial	495
Public/Quasi-Public	707
Industry – Heavy	18
Transportation, Communication	217
Utilities	2
Agriculture	490
Forest	12,267
Rangeland	4,100
Urban Recreation	425
Vacant, Undeveloped	396
Wetlands	101
Fresh Water	72
Total	*27,416*

(Source: ABAG Land Use Data 1995)

Table 8: Subwatershed Stream and Road Intersections Over Time

	1868-1899			1953-1955			1968			1999		
Subwatershed	**Paved Roads (miles)**	**Unpaved Roads (miles)**	**Stream/Road Intersections**	**Paved Roads (miles)**	**Unpaved Roads (miles)**	**Stream/Road Intersections**	**Paved Roads (miles)**	**Unpaved Roads (miles)**	**Stream/Road Intersections**	**Paved Roads (miles)**	**Unpaved Roads (miles)**	**Stream/Road Intersections**
San Francisquito Creek	0	57	6	149	9	24	192	14	24	194	14	33
Los Trancos Creek	0	11	3	17	8	26	31	15	26	36	15	26
Corte Madera Creek	0	17	0	16	10	13	28	14	13	36	15	16
West Union Creek	0	14	1	11	10	24	15	10	24	16	10	24
Bear Gulch	0	4	1	9	7	7	9	7	7	9	8	7
Bear Creek	0	6	0	20	1	10	26	2	10	26	2	12
Sausal Creek	0	5	0	9	6	11	11	9	11	12	9	11
Alambique Creek	0	6	0	5	11	4	7	12	4	7	12	4
Westridge Creek	0	1	0	4	3	2	7	4	2	7	4	2
Martin Creek	0	2	0	7	2	2	9	3	2	9	3	2

Table 9: Projected Residential, Industrial, and Commercial Development for the San Francisquito Watershed

Land Use Type	Land Available for Development (acres)	Land Projected for Development (acres)	Percentage of Available Land Projected for Development	Percentage of Watershed Projected for Development	Percent Buildout
Residential	8,090	1,666	21	36	59
Industrial/ Commercial	59	35	60	5	97
Total	*8,149*	*1,701*	*81*	*41*	*64*

Table 10: Existing and Projected Percent Imperviousness for San Francisquito Watershed (1995)

Year	Existing/Projected Acreage of Impervious Surfaces within Watershed	Existing/Projected Percent of Impervious Surfaces within Watershed
1995	5700	20.8
2020	7200	26.1

(Source: Watershed Management Initiative 2001, ABAG Land Use Data 1995)

Table 11: Habitat Types within Subwatersheds

Subwatershed	Habitat Acreages					
	Annual Grassland	Coastal Oak Woodland	Chamise-Redshank Chaparral	Montane Hardwood	Redwood	Urban
San Francisquito Creek	741	425				7313
Corte Madera Creek	517	1455		1204		1189
Los Trancos Creek	443	1294	745			2385
Alambique Creek		408		44	622	416
Martin Creek				49	467	272
Sausal Creek	25	234		122	252	911
Westridge Creek		261		438		378
Bear Creek	182	12				1387
Bear Gulch		560			1102	586
West Union Creek	26	166			3003	379

(Source: UCSB GAP Analysis, 1989)

Table 12: Occurrence of Fish in Collections from the San Francisquito Creek Drainage, 1855-1981

Species	Cutts 1855	Agassiz 1860	Hughs 1890	Snyder 1938	Shapovalov 1938	Grant and Stanton 1939	SJSU 1956-1957	CDFG 1966	CDFG 1974-1976	CDFG 1978-1979	Leidy 1981
Native Species											
Salmo gairdnerii	X			X	X				X	X	X
Lavinia symmetricus				X	X	X		X	X		X
Ptchocheilus grandis				X							
Gasterosteus aculeatus				X	X	X	X	X	X		X
Catastomus occidentalis			X	X					X	X	X
Archoplites interruptus		X									
Cottus asper				X	X		X		X		
Cottus gulosus											X
Nonnative Species											
Carassius auratus									X		
Lepomis cyanellus							X	X	X		
Lepomis macrochirus										X	
Micropterus salmoides							X				
Gambusis affinis											X
Lucania parva											X
Ictalurus nebulosus							X				
Percentage of Native Species	**100**	**100**	**100**	**100**	**100**	**100**	**40**	**66**	**71**	**66**	**71**

(Source: Distribution and Ecology of Stream Fishes in the San Francisco Bay Drainage, 1984)

Table 13: Historic and Current Freshwater Fish of the San Franciscquito Watershed

Historical Freshwater Fish	Current Freshwater Fish
Native Species	
Coho salmon (*Oncorhynchus kisutch*)	Speckled Dace (*Rhinichythys osculus*)
Rainbow/Steelhead trout (*Oncorhynchus mykiss*)	Rainbow/Steelhead Trout (*Oncorhynchus mykiss*)
California roach (*Lavinia symmetricus*)	California Roach (*Lavinia symmetricus*)
Sacramento sucker (*Catostomus occidentalis*)	Sacramento Sucker (*Catostromus occidentalis*)
Threespine stickleback (*Gasterosteus aculeatus*)	Threespine Stickleback (*Gasterosteus aculeatus*)
Prickly sculpin (*Cottus asper*)	Prickly Sculpin (*Cottus asper*)
Riffle sculpin (*Cottus gulosus*)	Riffle Sculpin (*Cottus gulosus*)
Chinook salmon (*Onchorhyhyrichus tshawytscha*)	Hitch (*Lavinia exilicauda*)
Sacramento pikeminnow (*Ptychocheilus grandis*)	
Sacramento perch (*Archopites interruptus*)	
Exotic Species	
	Rainwater Killifish (*Lucania parva*)
	Mosquitofish (*Gamusia affinis*)
	Bluegill sunfish (*Menidia audens*)
	Pumpkinseed (*Lepomis gibbosus*)
	Green sunfish (*Lepomis cyanellus*)
	Black crappie (*Pomoxis nigromaculatus*)
	Largemouth bass (*Micropterus salmoides*)
	Redear sunfish (*Lepomis microlophus*)

(Source: Watershed Management Initiative 2001)

Table 14: Steelhead Passage Barriers within the San Francisquito Watershed

Barrier Number	Sub-Watershed	Barrier Description	Type (anthropogenic/natural)	Recommended Action	Severity (low/moderate/high)
SF-1	San Francisquito	Dam/Weir	Anthropogenic	Notch to improve smolt passage (completed)	N/A
SF-2	San Francisquito	Dam/Weir	Anthropogenic	Cut shallow notch in all three weirs (completed)	N/A
SF-3	San Francisquito	Dam/Weir	Anthropogenic	Remove weir structure and replace with three cross vane weirs	Moderate
SF-4	San Francisquito	Bridge Apron/Culvert	Anthropogenic	Remove current crossing as part of planned San Hill Road widening	Moderate
SF-5	San Francisquito	Dam/Weir	Anthropogenic	Monitor	Low
SF-6	San Francisquito	Dam/Weir	Anthropogenic	Assess passage severity and possible improvements during lower flows	Low
SF-7	San Francisquito	Dam/Weir	Anthropogenic	Assess alternatives for improving fish passage	Low
SF-8	San Francisquito	Concrete Low Water Crossing	Anthropogenic	Monitor during winter flows to evaluate fish passage	Moderate
LT-1	Los Trancos	Dam/Weir	Anthropogenic	Monitor	Low
LT-2	Los Trancos	Dam/Weir	Anthropogenic	Monitor	Low
LT-3	Los Trancos	Dam/Weir	Anthropogenic	Monitor	Low
LT-4	Los Trancos	Dam/Weir	Anthropogenic	Improve for passage	Moderate
LT-5	Los Trancos	Dam/Weir	Anthropogenic	Initially remove wingwalls, roughen basin bottom	High
LT-6	Los Trancos	Bridge Apron/Culvert	Anthropogenic	Concentrate low flows into one culvert; install baffles in low-flow culvert to increase depth and reduce velocity	Moderate

Barrier Number	Sub-Watershed	Barrier Description	Type (anthropogenic/natural)	Recommended Action	Severity (low/moderate/high)
LT-7	Los Trancos	Bridge Apron/Culvert	Anthropogenic	Concentrate low flows into one culvert; install baffles in low-flow culvert to increase depth and reduce velocity	Moderate
BU-1	Los Trancos	Bridge Apron/Culvert	Anthropogenic	Modify to improve steelhead passage only if structure modified to provide increased flood capacity; design should prevent channel incision or draining of valuable upstream wetland	High
BE-1	Bear Creek	Dam/Weir	Anthropogenic	Cut shallow notch to move attraction flows (completed)	N/A
BE-2	Bear Creek	Logjam	Natural	Cut main log to open jam (completed)	N/A
BE-3	Bear Creek	Dam/Weir	Anthropogenic	Lower dam 2 to 2.5 feet to allow jump; remove concrete block at dam base	High
BE-4	Bear Creek	Dam/Weir	Anthropogenic	Cut shallow notch to move attraction flows	Low
BE-5	Bear Creek	Dam/Weir	Anthropogenic	None-no action needed	N/A
BE-6	Bear Creek	Pipeline Crossing	Anthropogenic	None-no action needed	N/A
BE-7	Bear Creek	Logjam	Natural	None-no action needed	N/A
BE-8	Bear Creek	Logjam	Natural	None-no action needed	N/A
BE-9	Bear Creek	Dam/Weir	Anthropogenic	None for passage (notch to create better summer pool for rearing habitat), but no action needed currently	N/A

Barrier Number	Sub-Watershed	Barrier Description	Type (anthropogenic/natural)	Recommended Action	Severity (low/moderate/high)
BE-10	Bear Creek	Bridge Apron/Culvert	Anthropogenic	Near-term: concentrate low flows into one culvert; install baffles in low-flow culvert to increase depth and reduce velocity; remove downstream vertical bars. Long-term: consider bridge replacement	Moderate
BG-1	Bear Creek	Logjam	Natural	None-currently community dialogue is being initiated with the town engineer about options	N/A
BG-2	Bear Creek	Logjam	Natural	Cut upper log to prevent more severe jam (completed)	N/A
BG-3	Bear Creek	Logjam	Natural	Cut and remove portions of the jam (completed)	N/A
BG-4	Bear Creek	Bridge Apron/Culvert	Anthropogenic	If passage at BG-5 is improved, install baffles to increase depth, reduce velocity. Long-term: consider bridge replacement	Moderate
BG-5	Bear Creek	Dam/Weir	Anthropogenic	Evaluate potential modification options with owner	High
BG-6	Bear Creek	Falls	Natural	None-no action is needed	N/A
WU-1	Bear Creek	Bridge Apron/Culvert	Anthropogenic	Install curbs and baffles to increase depth and reduce velocity; move boulders from below drop	Moderate
WU-2	Bear Creek	Fence	Anthropogenic	Monitor removal during rainy season or replace fence with larger mesh size	Moderate
WU-3	Bear Creek	Dam/Weir	Anthropogenic	Cut notch three feet wide by one foot deep	Moderate
WU-4	Bear Creek	Logjam	Natural	None-no action needed	N/A
WU-5	Bear Creek	Logjam	Natural	None-no action needed	N/A

Barrier Number	Sub-Watershed	Barrier Description	Type (anthropogenic/natural)	Recommended Action	Severity (low/moderate/high)
WU-6	Bear Creek	Dam/Weir	Anthropogenic	None for passage (notch to create better summer pool for rearing habitat)	Low
WU-7	Bear Creek	Dam/Weir	Anthropogenic	None for passage (notch to create better summer pool for rearing habitat)	Low
WU-8	Bear Creek	Logjam	Natural	None-no action needed	N/A
WU-9	Bear Creek	Falls	Natural	None-no action needed	N/A
SG-1	Bear Creek	Bridge Apron/Culvert	Anthropogenic	None-no action needed	N/A
SG-2	Bear Creek	Logjam	Natural	Remove logjam if permitting effort is low (completed)	N/A
SG-3	Bear Creek	Logjam	Natural	Cut pipe to remove debris jam if permitting effort is low (completed)	N/A
MG-1	Bear Creek	Falls	Natural	None-no action is needed	N/A
MG-2	Bear Creek	Bridge Apron/Culvert	Anthropogenic	Eliminate apron or rim with curb to eliminate two-step entrance to culvert; baffles in culvert would improve passage during low flows	Moderate
MG-3	Bear Creek	Logjam	Natural	None-no action needed	N/A
MG-4	Bear Creek	Logjam	Natural	None-no action needed	N/A
MG-5	Bear Creek	Falls	Natural	None-no action needed	N/A
MG-6	Bear Creek	Bridge Apron/Culvert	Anthropogenic	None-no action needed	N/A
CM-1	Corte Madera	Dam/Weir	Anthropogenic	To be determined through long-term planning process. Dam modification alternatives being discussed	High
CM-2	Corte Madera	Revetment	Anthropogenic	Monitor (completed)	N/A

Barrier Number	Sub-Watershed	Barrier Description	Type (anthropogenic/natural)	Recommended Action	Severity (low/moderate/high)
CM-3	Corte Madera	Dam/Weir	Anthropogenic	Cut shallow notch to concentrate flows and improve summer pool habitat	High
CM-4	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Remove concrete instream and stabilize/modify bridge or replace with wider span	High
CM-5	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Remove concrete instream and stabilize/modify bridge or replace with wider span	Unknown
CM-6	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Remove concrete instream and stabilize/modify bridge or replace with wider span.	High
CM-7	Corte Madera	Bridge Apron/ Culvert	Anthropogenic	Remove old structure and replace with bridge	High
AL-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Remove old structure and replace with bridge	High
AL-2	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Unknown
AL-3	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Unknown
DM-1	Corte Madera	Dam/Weir	Anthropogenic	Unknown	Unknown
DM-2	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Unknown
DM-3	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	High
DM-4	Corte Madera	Dam/Weir	Anthropogenic	Unknown	High
SA-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Moderate
SA-2	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Consider daylighting as amenity to Portola Valley town center	High
BR-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	High
DA-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Low
RE-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Low
RE-2	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	Unknown
CO-1	Corte Madera	Bridge Apron/Culvert	Anthropogenic	Unknown	High

Table 15: Land Use Acreages within Riparian Corridors within San Francisquito Watershed

Land Use Type	Acreage
Forest	906
Residential	561
Rangeland	130
Vacant/Undeveloped	75
Agriculture	70
Urban Recreation	50
Wetlands	40
Public/Quasi-Public	20
Commercial	19
Transportation/Communication	15
Freshwater	14
Heavy Industrial	4

(Source: Watershed Management Initiative 2001, ABAG Land Use Data 1995)

Table 16: Riparian Policies from Santa Clara and San Mateo County General Plans

Santa Clara County	
Urban Growth and Development – 6	Hazard and resource areas, including riparian corridors, shall be considered unsuitable for urban development
Urban Resource Conservation – 2	The County shall provide leadership in efforts to protect or restore valuable natural resources, such as wetlands, riparian areas, and woodlands
Urban Resource Conservation – 19	The strategies for maintaining and improving water quality on a county wide basis, in addition to ongoing point source regulation, should include restoration of wetlands, riparian areas, and other habitats which serve to improve Bay water quality
Urban Resource Conservation – 31	Areas of habitat richest in biodiversity and necessary for preserving threatened or endangered species should be formally designated to receive greatest priority for preservation, including baylands and riparian areas, serpentine areas, and other habitat types of major significance
Rural Parks and Recreation – 14	Privately owned recreational land uses and facilities within rural unincorporated areas, including but not limited to golf courses, campgrounds, and similar uses, should be compatible with the landscape and resources of the areas in which they are proposed. To ensure such compatibility, potentially significant impacts often associated with such land uses should be avoided or reduced to less than significant levels, including riparian areas
Rural Resource Conservation – 2	The County shall provide leadership in protecting and restoring valuable natural resources, such as wetlands, riparian areas, and others, for County-owned lands and by means of multi-jurisdictional endeavors
Rural Resource Conservation - 31	Natural streams, riparian areas, and freshwater marshes shall be left in their natural state providing for percolation and water quality, fisheries, wildlife habitat, aesthetic relief, and educational or recreational uses that are environmentally compatible
Rural Resource Conservation – 32	Riparian and freshwater habitats shall be protected through the following general means: a. setback of development from the top of the bank b. regulation of tree and vegetation removal c. reducing or eliminating use of herbicides, pesticides, and fertilizers by public agencies d. control and design of grading, road construction, and bridges to minimize environmental impacts and avoid alteration of the streambed and stream banks e. protection of endemic, native vegetation
Rural Resource Conservation – 35	Flood control modifications to be made in streams that have substantial existing natural areas should employ flood control designs which enhance riparian resources and avoid to the maximum extent possible significant alternation of the stream, it's hydrology, and its environs
Rural Resource Conservation – 36	In cluster residential developments or other projects where open space dedication is required, the stream, riparian areas, and freshwater marshes should be included within the restricted open space area of the project or protected by other enforceable mechanisms, such as deed restrictions or conservation easements

Rural Resource Conservation – 39	Within areas immediately adjacent to the stream buffer area, new development should minimize environmental impacts on the protected bummer area, and screening of obtrusive or unsightly aspects of a project should be considered as a means of preserving the scenic value of riparian areas
Rural Resource Conservation – 40	Where new roads, clustered residential development, or subdivisions are proposed in proximity of streams and riparian areas, they should be designed so that riparian vegetation is retained
Rural Resource Conservation – 41	Where trails and other recreational uses are proposed by adopted plans to be located in the vicinity of streams and riparian areas or reservoirs, trail alignments and other facilities should be placed on the fringe of the riparian buffer area or at an appropriate distance to avoid disturbance of the stream or vegetation
Rural Resource Conservation – 54	Restoration of stream channels and riparian areas should be encouraged wherever feasible. Multiple users, such as for recreational trails, should be considered so long as habitat and other ecological values are preserved
Rural Health and Safety – 31	Flood control measures should be considered part of an overall community improvement program and should advance the goal of preserving and enhancing riparian vegetation and habitats
San Mateo County	
Role of the County 1.47 Develop Guidelines for Vegetation and Debris Control in Riparian Corridors	Develop guidelines for vegetation and debris control in riparian corridors. Such guidelines should set forth clear direction on procedures to: 1) facilitate the abatement of avoidable flood hazards and 2) minimize adverse impacts on riparian communities
Role of the County 1.48 Encourage the Management of Riparian Corridors	Encourage, and to the maximum extent feasible, reward the efforts of those responsible for managing riparian corridors in a manner that is consistent with County and State Guidelines
Rural Site Planning 4.26 Water Bodies	b. Discourage structures which would adversely impact the appearance of a stream and associated riparian habitat
General Policies 15.45 Abatement of Flooding Hazards	Support measures for the abatement of flooding hazards, including debris clearance and silt removal programs conducted in a manner so as not to disrupt existing riparian communities

(Source: Santa Clara County General Plan (1994) and San Mateo County General Plan (1986))

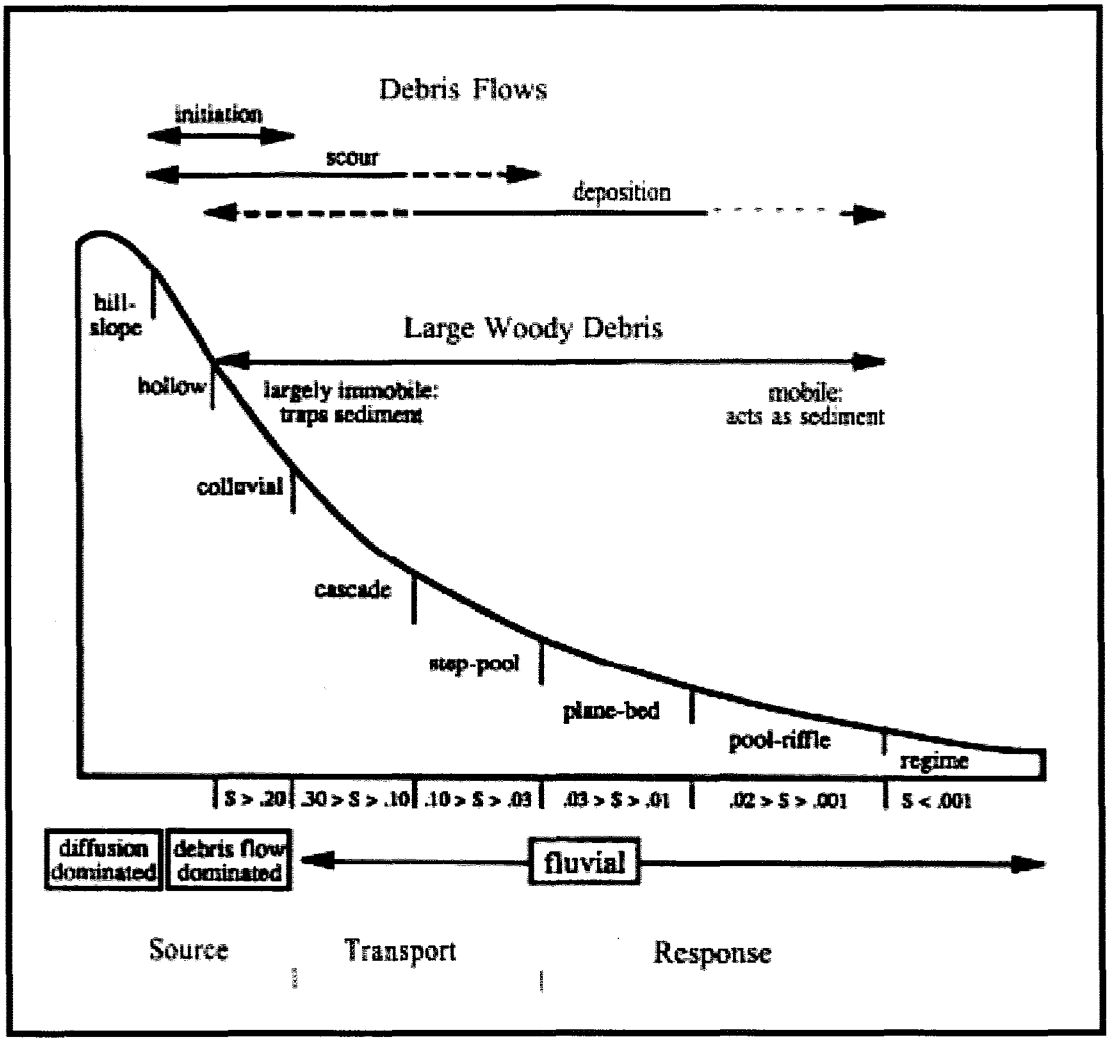
Table 17: Existing and Potential Beneficial Land Uses within the San Francisquito Watershed

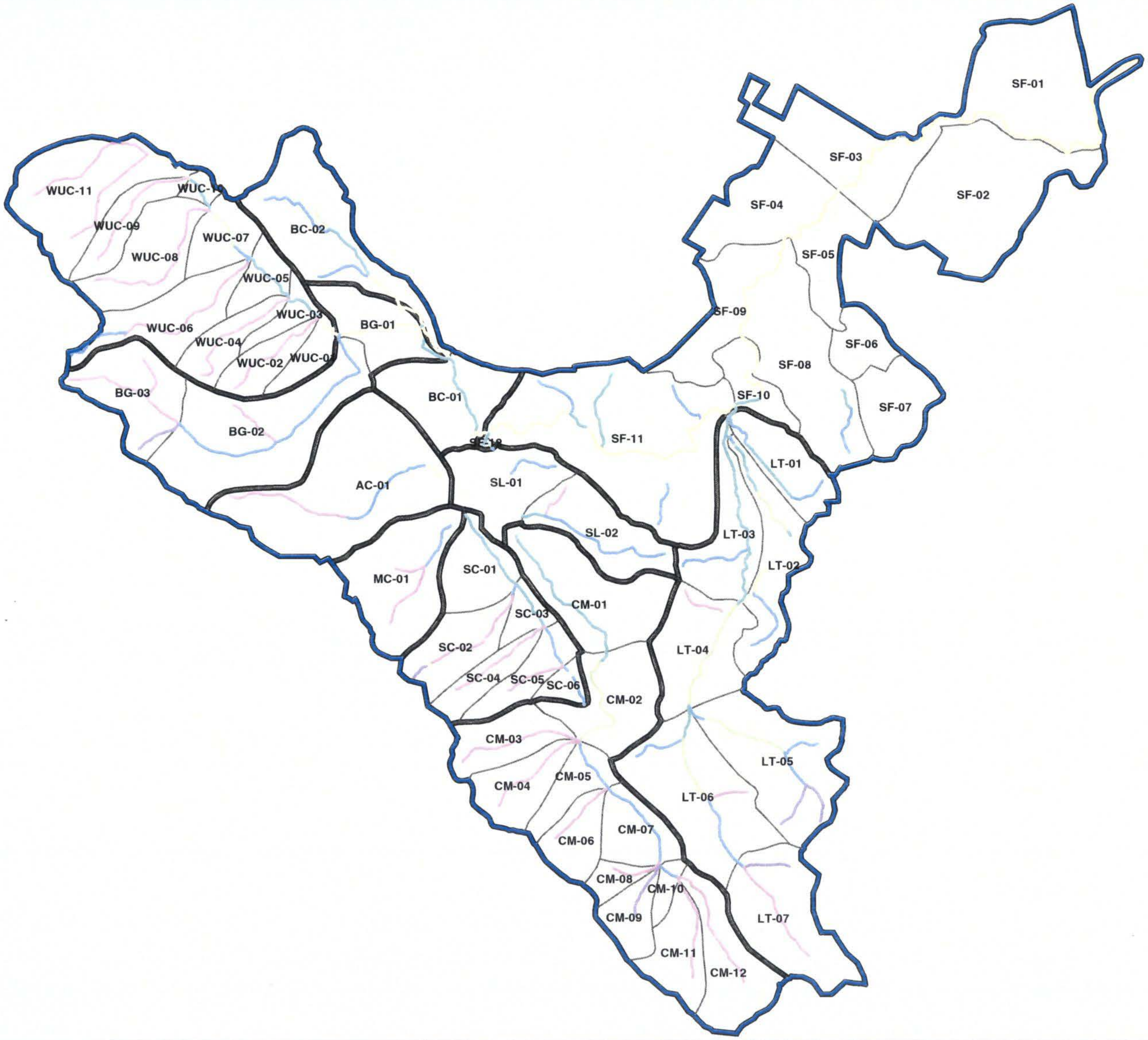
Waterbody	Existing Beneficial Land Uses	Potential Beneficial Land Uses
San Francisquito Creek	Coldwater Freshwater Habitat Fish Migration Fish Spawning Warm Freshwater Habitat Wildlife Species	Water Contact Recreation Non-Contact Water Recreation
Searsville Lake	Agricultural Supply Coldwater Freshwater Habitat Water Contact Recreation Non-Contact Water Recreation Fish Spawning Warm Freshwater Habitat Wildlife Species	
Felt Lake	Agricultural Supply Water Contact Recreation Non-Contact Water Recreation Fish Spawning Warm Freshwater Habitat Wildlife Species	

(Source: Water Quality Control Plan for the San Francisco Bay Basin (1995))

Figures

Figure 1. Generalized Stream Classification from Montgomery and Buffington (1993)





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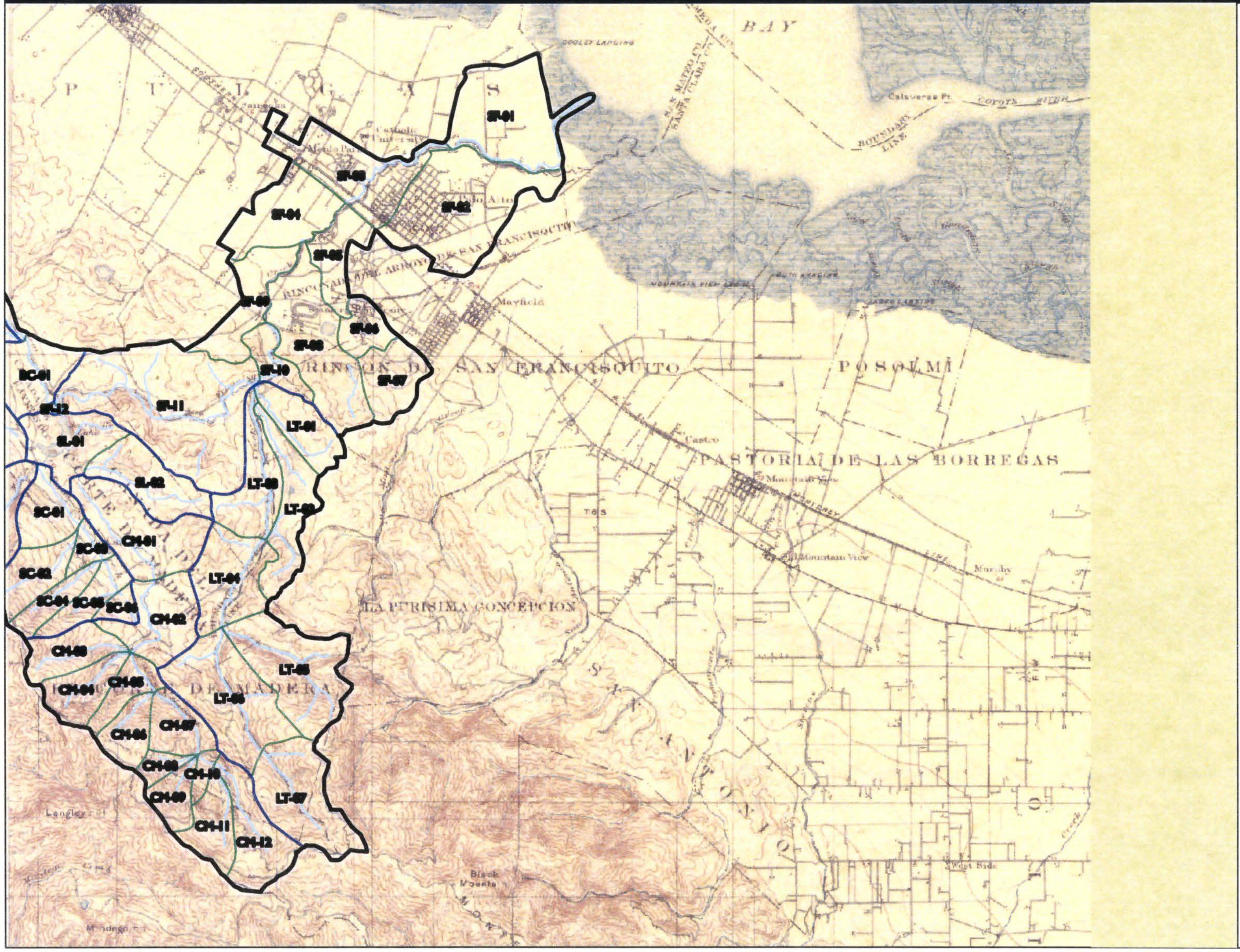

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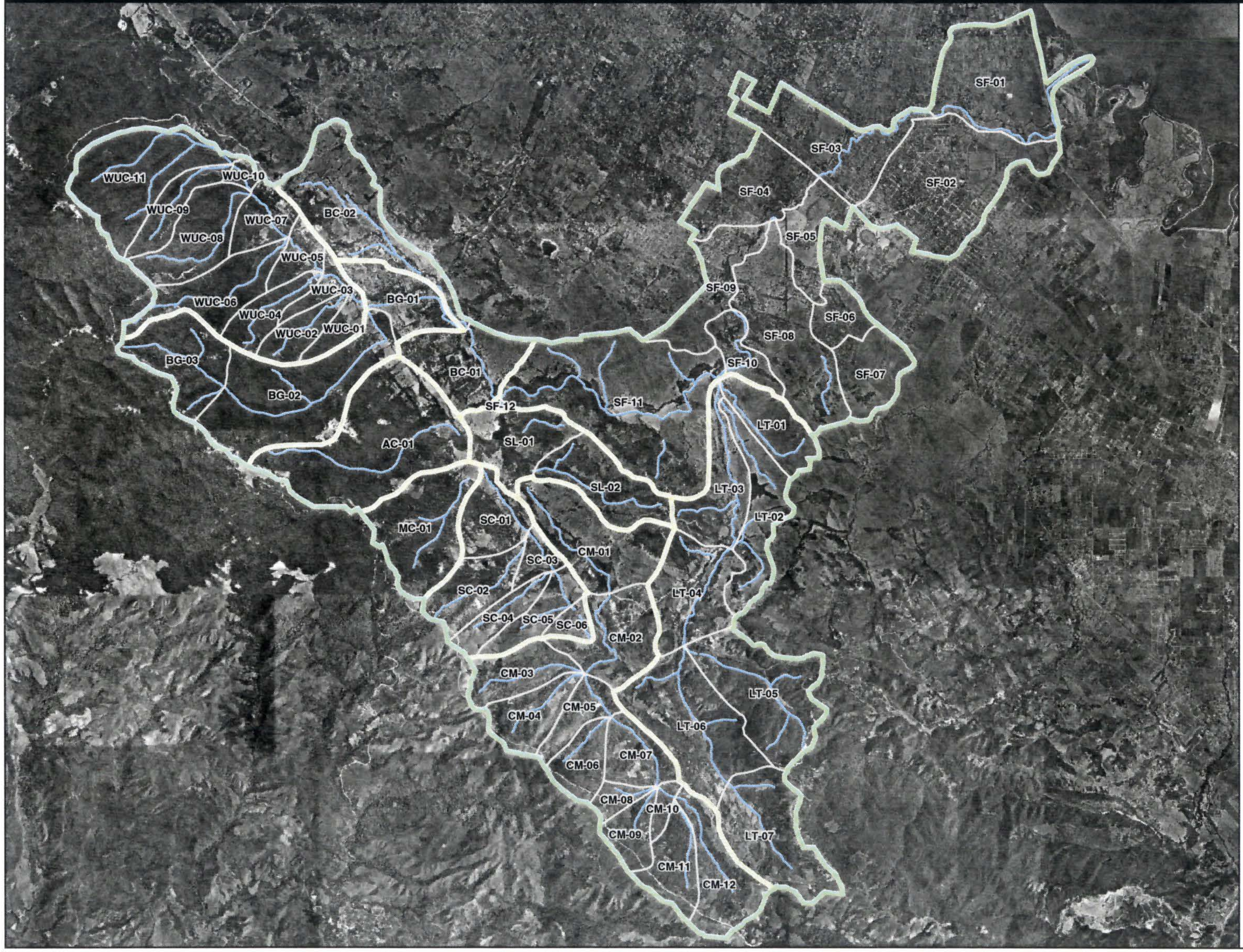

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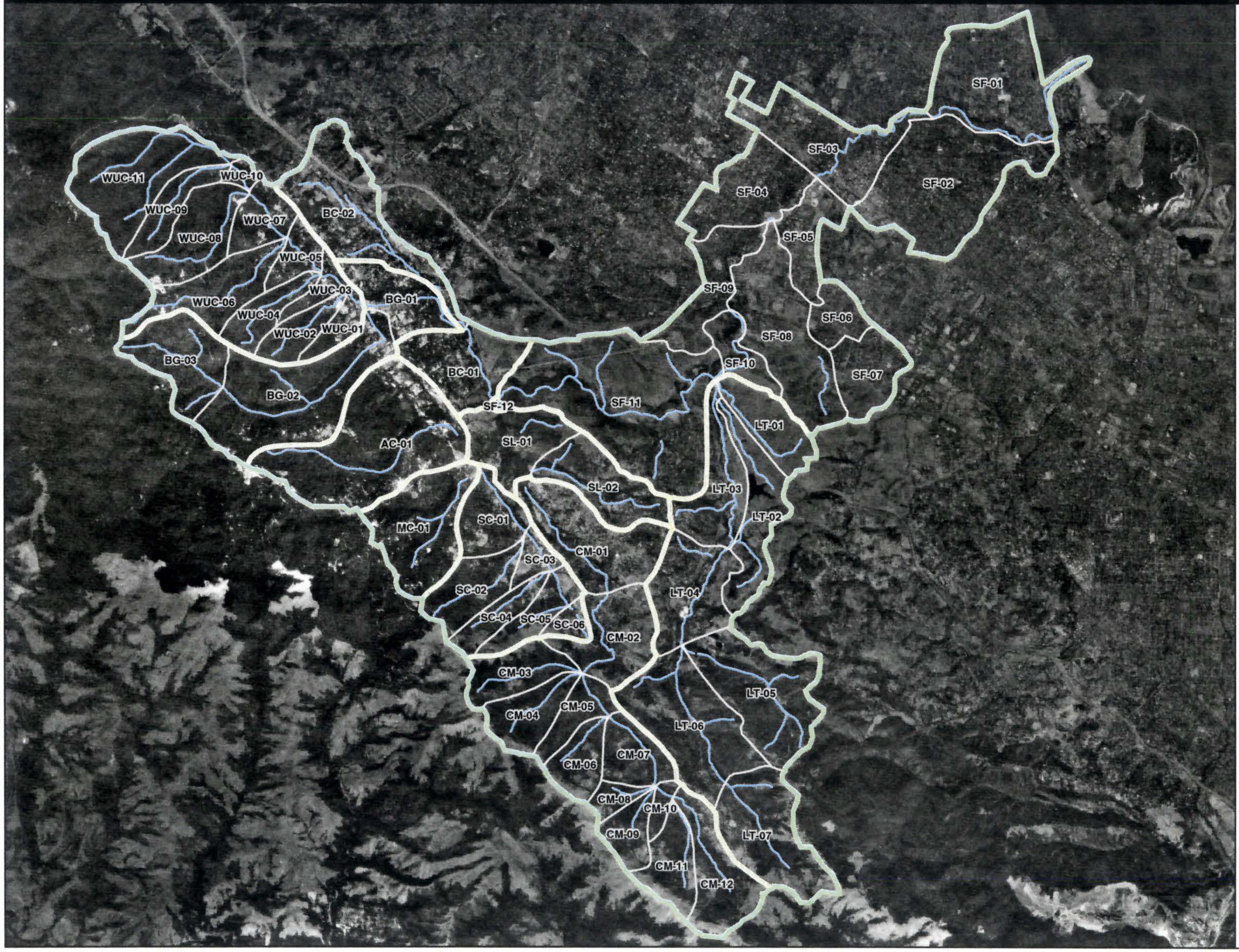

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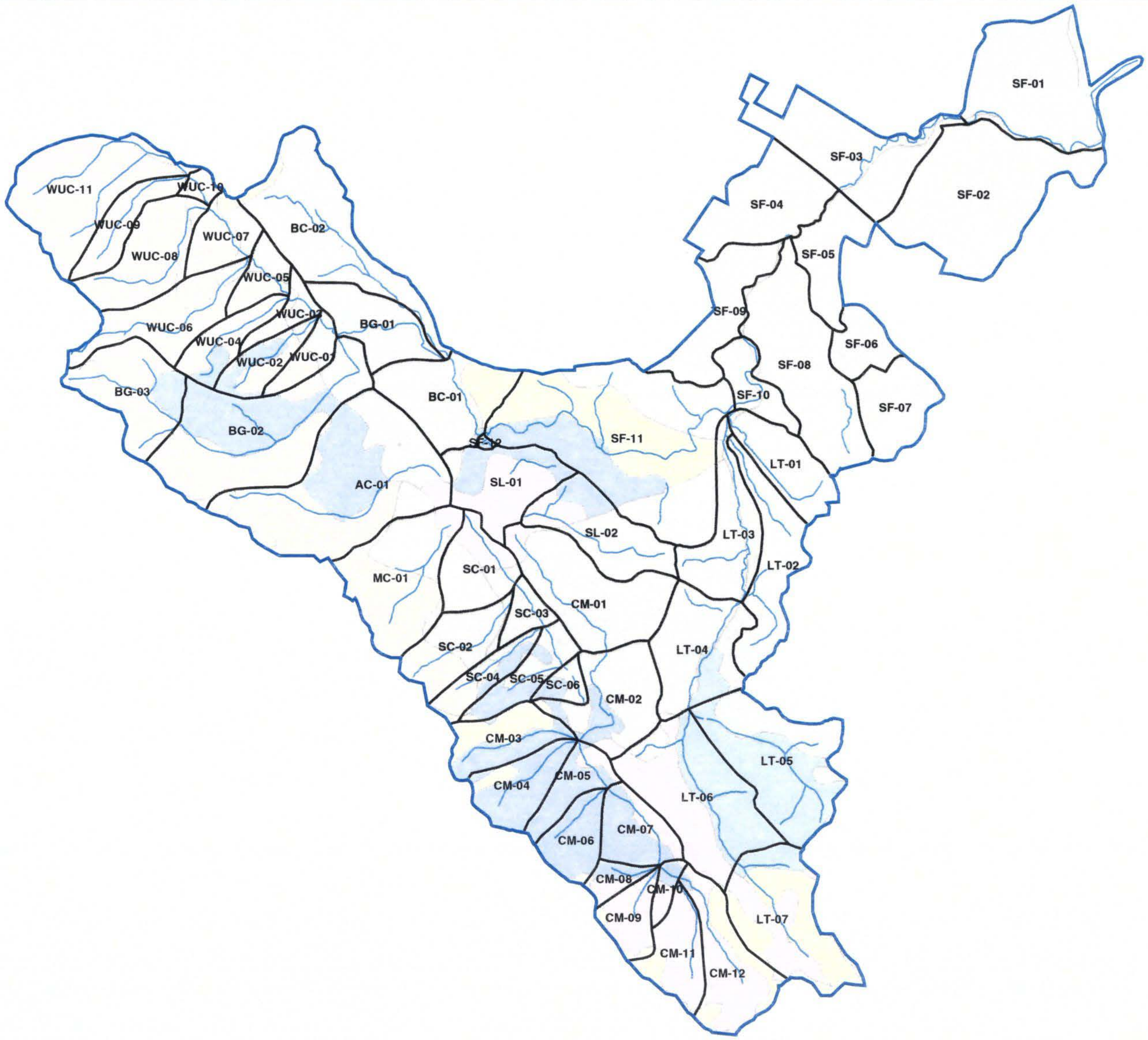

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Figure 7 Steelhead Passage Barriers within the San Francisquito Creek Watershed

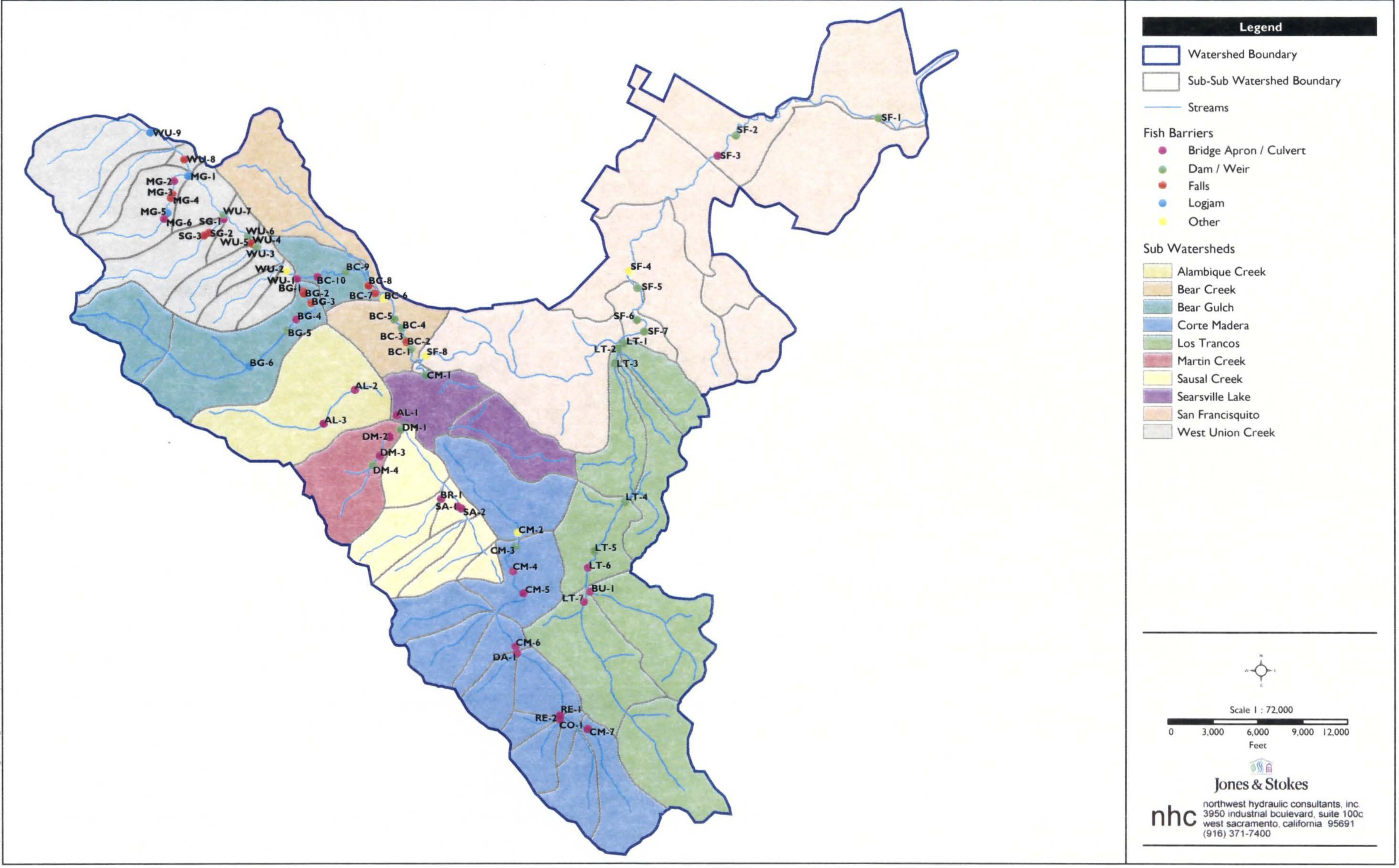

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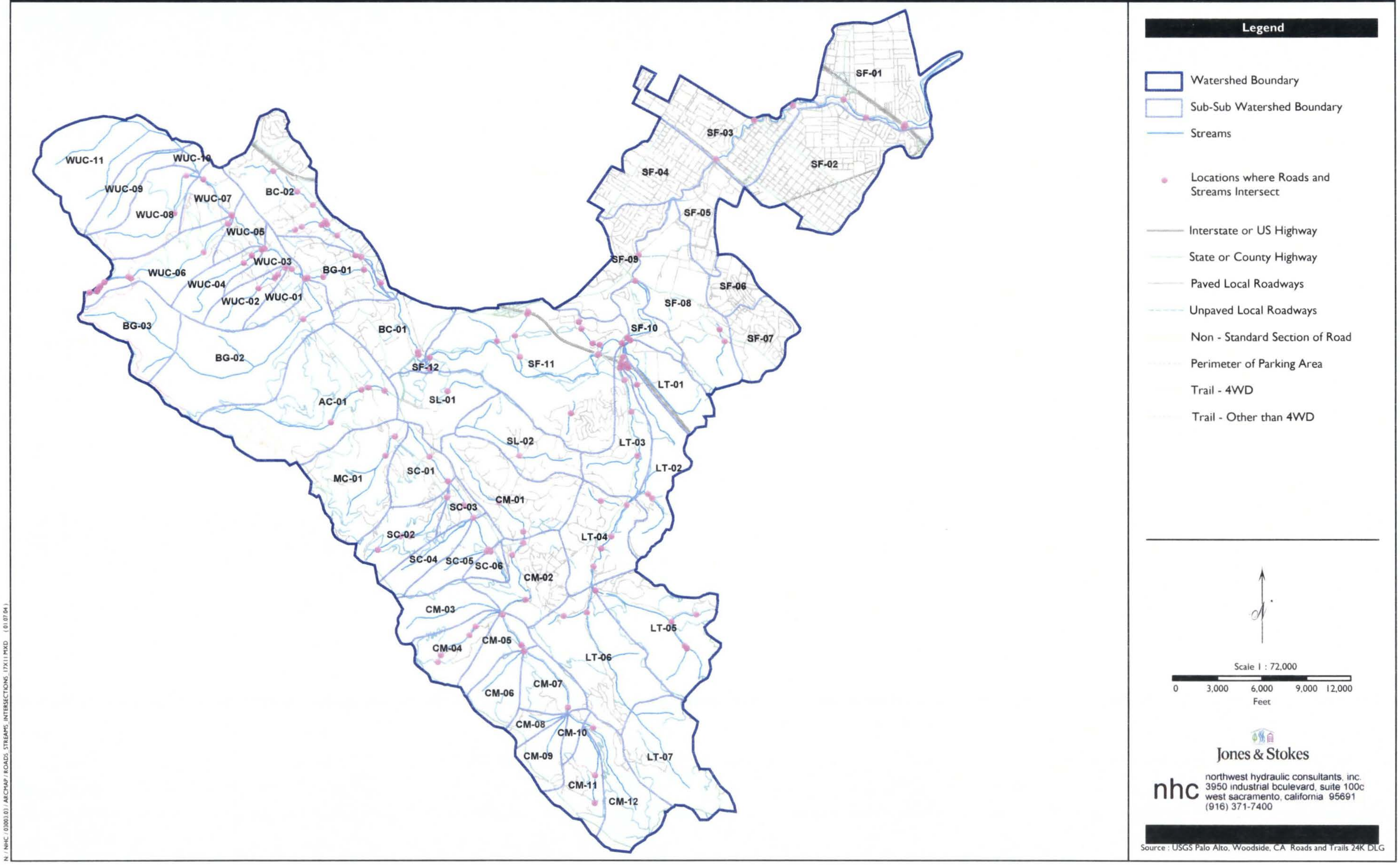
Figure 8 Road and Stream Intersections - San Francisquito Creek Watershed



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Source : USGS Palo Alto, Woodside, CA Roads and Trails 24K DLG

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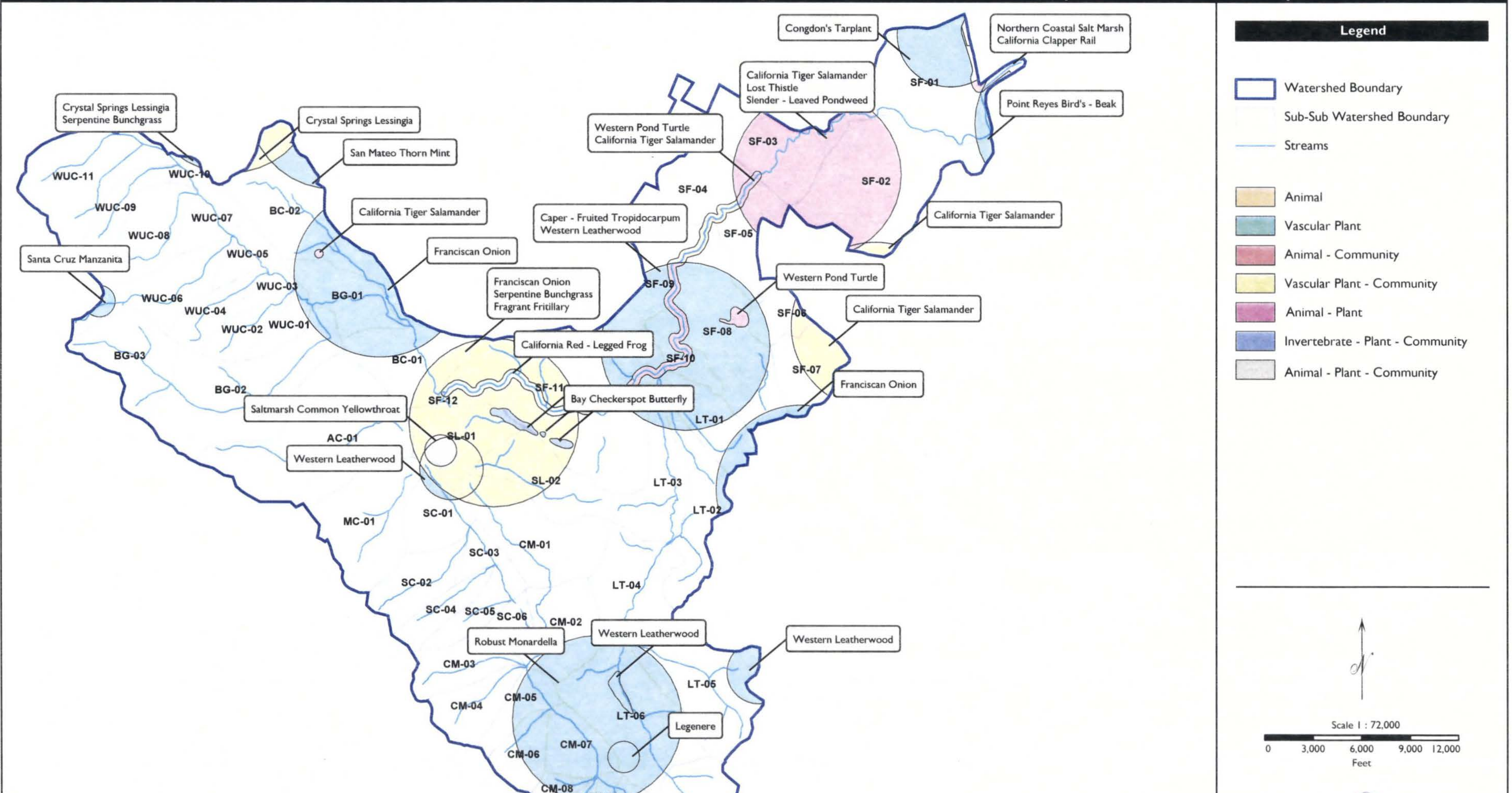
Figure 9 California Natural Diversity Database - San Francisquito Creek Watershed



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Source : CNDDB

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